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IN ALL ITS APPLICATIONS TO

PHARMACY, ARTS, AND MANUFACTURES.

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THE CHEMICAL NEWS.

VOLUME LVI.

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No. 1441.—JULY 8, 1887.

CONTRIBUTIONS TO OUR KNOWLEDGE OF ANTIMONY PERCHLORIDE.*

By RICHARD ANSCHÜTZ and P. NORMAN EVANS.

SOME months ago† we showed that antimony pentachloride can be distilled, undecomposed, under much diminished pressure; our next step was the attempt to determine the vapour-density under similar conditions. The fact that the boiling point of antimony pentachloride lies much lower than that of the trichloride would seem to show that the vapour-density of the pentachloride, as in the case of the trichloride, corresponds to the simpler formula. Nevertheless, on account of the fundamental importance which the establishment of the simple formula $SbCl_5$ would have for the valence of antimony, it seemed indispenably necessary to make a determination of the vapour-density. We will preface our further observations with the remark that we have not yet succeeded in determining the vapour-density of antimony pentachloride under diminished pressure; however, in the course of many unsuccessful attempts which we have made to this end, we had one point thrust on our notice, which on investigation led to some important results concerning our knowledge of the chemical nature of antimony pentachloride.

Antimony pentachloride is well known to be an extremely hygroscopic body. Consequently in the application of La Coste's modification of Victor Meyer's method for the determination of vapour-densities under diminished pressure, it was necessary to substitute liquid paraffin for water; yet, in spite of numerous careful experiments, we could not attain our object, the liquid paraffin offered too great a resistance to the air, and before all the air had been driven out the antimony pentachloride distilled into the upper and cooler parts of the apparatus. During these experiments it was proved to us that it is next to impossible to prevent the formation of traces of the white substance, which is the result of the action of water on antimony pentachloride. We were accordingly constrained to put this method aside.

Before attempting the determination of antimony pentachloride by another method, we deemed it best first to find out the nature of the error caused by the formation of the minute amount of the product of water reacting on antimony pentachloride.

After careful consideration we were struck by the contradiction between the conclusions of Daubrawa‡ and those of R. Weber,§ concerning the behaviour of antimony pentachloride with water. According to the latter, antimony pentachloride forms with water a hydrate, which is impossible if with 1 mol. of water antimony pentachloride is changed in the cold to $SbOCl_3$ and 2 mols. of hydrochloric acid, as Daubrawa thinks he has proved.

The following results of our experiments show that Daubrawa's statements concerning antimony oxychloride, $SbOCl_3$, are entirely wrong. In connexion with these studies we have occupied ourselves with the action of oxalic acid on antimony pentachloride, and have succeeded in obtaining the remarkable product of this reaction in a pure state.

Reaction of Water on Antimony Pentachloride.

Daubrawa allowed 1 part by weight of distilled water to drop from a pipette into a flask, surrounded by ice, containing 16 parts by weight of antimony pentachloride. He found the decomposition accompanied by hissing, and by the formation of vapour, giving no white pulverulent precipitate, but forming a yellowish distinctly crystalline mass, which adhered to the flask. This crystalline mass, the behaviour of which with water Daubrawa describes in detail, is, according to his analysis, antimony oxychloride, $SbOCl_3$, and he expresses its formation from antimony pentachloride and water by the following equation;—

$$Sb\begin{cases}Cl\\Cl\\Cl\\Cl\\Cl\end{cases} + H_2O = SbOCl_3 + 2HCl.$$

We proceeded exactly as above described, and joined to our flask a receiver containing a weighed quantity of water in which to collect the liberated hydrochloric acid. To 21·5 grms of well-cooled antimony pentachloride, which had been purified by distillation under diminished pressure, we added drop by drop 1·2 grm., the calculated amount, of water, and found to our surprise that no hydrochloric acid was liberated; also that the yellowish crystalline product was equal in weight to the sum of the weights of the water and antimony pentachloride originally taken.

The resulting product was only partly soluble in chloroform, and was therefore a mixture of different substances.

We therefore altered the conditions of the experiment. In order to moderate the reaction we dissolved 20·4 grms. of pure antimony pentachloride in about the same volume of chloroform, and added drop by drop to the cooled solution the calculated amount, 1·1 grm., of water, shaking constantly. The formation of the new body was soon apparent by the separation of almost colourless crystals; the yellow colour of the chloroform, caused by

* A Paper read before the Royal Society, June 16, 1887.
† *Chem. Soc. Journ.*, vol. xlix., 1886, p. 708.
‡ *Liebig's Annalen*, vol. clxxxvi., 1887, p. 118.
§ *Poggendorff, Annalen*, vol. cxxv., 1865, p. 86.

the antimony pentachloride (which according to our experience is never colourless, but always a bright yellow liquid), gradually disappeared, and at the end of the reaction the crystals which had separated were covered by colourless liquid. Under these changed conditions there was again no trace of hydrochloric acid set free. We next heated our product nearly to the boiling point of chloroform, adding sufficient dry chloroform to dissolve the crystals which had separated. From this solution a compound was deposited in feathery crystals. After decanting the mother-liquor, these were washed with a small quantity of chloroform and placed to dry in a vacuum desiccator on a porous plate that had been previously heated. This body is so extraordinarily hygroscopic that the analyses were not very easy; however, the results leave no doubt that $SbCl_5H_2O$ is the formula :—

Grms.

1. 0·2719 substance gave 0·6074 AgCl.
2. 0·1457 ,, ,, 0·3270 AgCl.
3. 0·1467 ,, ,, 0·3290 AgCl.
4. 0·3003 ,, ,, 0·1461 Sb_2O_4.
5. 0·3104 ,, ,, 0·1492 Sb_2O_4.
6. 0·2020 ,, ,, 0·1061 Sb_2S_3.
7. 1·1387 ,, ,, 0·0961 H_2O } Combustion with
8. 1·3905 ,, ,, 0·1180 H_2O } lead chromate.

	Calculated for $SbCl_5H_2O$.	Found.							
		1.	2.	3.	4.	5.	6.	7.	8.
Cl	55·90	55·26	55·52	55·48	—	—	—	—	—
Sb	38·42	—	—	—	38·53	38·08	37·69	—	—
H	0·63	—	—	—	—	—	—	0·93	0·94
O	5·04								
	99·99								

We provisionally designate this body as antimony pentachloride monohydrate, without expressing any opinion concerning the constitution of this addition product of equal molecules of water and antimony pentachloride. From chloroform, the monohydrate crystallises in leafy or feathery crystals resembling sal-ammoniac, having a melting point lying between 87° and 92°. If exposed to the air it deliquesces to a clear liquid, which over sulphuric acid gradually crystallises again in broad needles, described by Daubrawa as a property of his supposed oxychloride. We have not further examined this body.

When one tries to distil the antimony pentachloride monohydrate under diminished pressure—under 20 m.m. with the bath at 105°—a mobile yellow liquid distils over; this, after two rectifications, boiled constantly at 73° under 17 m.m. (bath 90°). Two chlorine determinations gave, as was expected, results for antimony pentachloride.

1. 0·2510 grm. substance gave 0·5965 AgCl.
2. 0·2879 ,, ,, 0·6885 AgCl.

	Calculated for $SbCl_5$.	Found. I.	Found. II.
Cl	59·24	58·80	59·15

There separated from a fraction boiling somewhat higher crystals of antimony trichloride, leaving a residue of a waxy consistency which could not be distilled.

22·7 grms. $SbCl_5H_2O$ gave 12·8 grms. $SbCl_5$.
,, ,, 1·1 grms. $SbCl_3$.
,, ,, 6·4 grms. residue.
,, ,, 2·4 loss.

Although after this experience it was not probable that we could obtain antimony oxychloride, $SbOCl_3$, by heating antimony pentachloride monohydrate, we repeated the experiment in another form. We heated 24·4 grms. of antimony pentachloride, mixed with about twice its volume of chloroform and 1·4 grms. water, in a closed tube to 100° on a water-bath. The crystals of the monohydrate which were first formed went into solution, and on opening the tube before a lamp at the end of six hours we found much pressure; a gas smelling like phosgene was liberated. The tube was again closed and heated afresh to 100°. The opening and closing was repeated, first at intervals of six hours, and later, as the pressure diminished, of twelve hours, until after about fourteen days the pressure was no longer noticeable.

On working up the products of the reaction we found, besides antimony tri- and penta-chlorides, *phosgene* in solution in the chloroform, from which we prepared diphenyl carbamide, m.-p. 239°. For the formation of phosgene gas it is not necessary to work in close tubes. A chloroform solution of the monohydrate, heated to its boiling point on a water-bath, yields a steady stream of phosgene mixed with hydrochloric acid. A similar decomposition takes place when carbon tetrachloride is heated with antimony pentachloride monohydrate in a closed tube to 100°. We will communicate the quantitative relations of this reaction after we have verified our first observations by repeated research.

One can make the tetrahydrate of antimony pentachloride even more easily than the monohydrate. For this purpose we dissolved 29·3 grms. of antimony pentachloride in about twice its volume of chloroform, and after surrounding the flask containing this solution with ice, let fall drop by drop 7 grms., the calculated quantity, of water. Again, in this experiment, no hydrochloric acid was given off. The mixture remained at first liquid, but when placed in a vacuum desiccator over sulphuric acid and paraffin, there separated slowly a hard crystalline mass, which was quite insoluble in chloroform. Two chlorine determinations made after washing the substance with chloroform agree with the formula $SbCl_5H_8O_4$.

1. 0·3963 grm. substance gave 0·7696 AgCl.
2. 0·3414 ,, ,, 0·6530 AgCl.

	Calculated for $SbCl_5H_8O_4$.	Found. I.	Found. II.
Cl	47·77	48·04	47·31

Thus besides the monohydrate of antimony pentachloride a tetrahydrate also exists, the latter being easily prepared from a chloroform solution of the former by the action of water, and differing from the monohydrate among other things in being insoluble in chloroform.

From the foregoing evidence it appears that antimony oxychloride, $SbOCl_3$, is certainly not formed by the action of water on antimony pentachloride; but if equal molecules of these substances are allowed to react, the compound $SbCl_5H_2O$ is formed, which we have called antimony pentachloride monohydrate. This product is most conveniently formed when water acts on chloroform solution of antimony pentachloride, without setting free hydrochloric acid, according to the equation—

$$SbCl_5 + H_2O = SbCl_5H_2O.$$

When one brings together weights equivalent to 1 mol. of antimony pentachloride and 4 mols. of water, the tetrahydrate of antimony pentachloride is formed, as described by R. Weber. We must put aside Daubrawa's contradiction of the facts of R. Weber, and strike Daubrawa's hypothetical antimony oxychloride, $SbOCl_3$, from the list of the known antimony compounds.

(To be continued.)

PECULIAR FORMATION IN NICKEL REGULUS.

By THOMAS MOORE.

THE formation referred to consists of symmetrically shaped pieces or flakes of an iron-nickel alloy, exceedingly ductile and malleable, which separate out from the molten regulus when slowly cooled. The flakes in question have a very brilliant appearance, and may sometimes be obtained one-sixteenth of an inch in thickness. Two analyses of the flakes made in 1881 gave the following results:—

	a.	*b.*
Copper	1·600	0·250
Nickel	70·300	87·863
Iron	28·300	11·865
	100·200	99·978

a. Regulus contained 13·5 per cent Fe. *b*. Regulus contained 15·6 per cent Fe.

Since the regulus from which both of the samples were obtained contained copper, another sample was recently obtained from a nickel regulus free from that metal, with the following results:—

	c	*d.*	*e.*
Nickel.. ..	86·40	72·100	73·80
Iron	13·72	2·315	4·27
Sulphur ..	none	25·506	22·01
	100·12	99·921	100·08

c. Flakes thoroughly freed from adhering regulus. *d*. Regulus surrounding the imbedded flakes. *e*. Regulus suddenly cooled to prevent formation of flakes.

Now, the strange thing in connection with this is that an absolutely sulphur-free alloy of nickel and iron should separate out from, and exist still free from sulphur in a metal bath containing at least one fourth of its weight of that element, in spite of powerful affinities, and this singularity is the more striking when it is remembered that one hundredth of a per cent of sulphur will render nickel useless as far as malleability is concerned.

I should just like to add that under favourable conditions the regulus may contain 10 per cent of the alloy.

Erdington, June 25, 1887.

DIRECT PRECIPITATION OF NICKEL OXIDE IN PRESENCE OF IRON.

By THOMAS MOORE.

IT seems quite useless to attempt to precipitate oxide of nickel free from iron from solutions of the simple salts of these metals, for the simple reason that oxide of nickel is capable of precipitating ferric hydrate from such solutions. If, however, both metals are converted into the double cyanides, the iron into ferro- or ferricyanide of potassium, and the nickel into the nickelo-cyanide of potassium, then it is possible, by the action of bromine and potassic hydrate, to convert the iron into soluble ferricyanide of potassium, whilst the nickel, being incapable of forming an analogous compound, is precipitated as the insoluble black nickelic hydrate. By the simple addition of potassic cyanide to a ferric solution it is exceedingly difficult to obtain complete solution, owing probably to the formation of different cyanide compounds; if, however, a little glacial phosphoric acid be previously added a clear solution is at once obtained, which, after boiling, is not precipitated by potassic hydrate, and consists chiefly of potassic ferrocyanide, and some other red compound which as yet I have not been able to determine. Based on the above facts, I adopted the following process for the assay of nickel ores, &c., when it is necessary to estimate that metal only. The solution of the two metals is freed, as far as possible, from acids, glacial phosphoric acid (sodic pyrophosphate may also be employed) is added until the precipitate first formed commences to dissolve, and then an excess of potassic cyanide, which will dissolve the remainder and form a red or yellow solution according to the amount of phosphoric acid added. Heat the solution and keep boiling for a minute or two, adding more cyanide at intervals until a drop of potassic hydrate ceases to give a precipitate. After the solution has become cold render very distinctly alkaline with potassic hydrate, then throw down the nickel by the addition, in considerable excess, of a strong solution of bromine in potassic hydrate, then warm the liquid to facilitate the precipitation. Filter off the black precipitate and wash well out, dissolve it off the filter in warm dilute sulphuric acid, and after saturating with ammonia, deposit the nickel electrolytically from the warm solution. Any cobalt present remains with the iron, but manganese will be found in the nickel solution completely or partly deposited on the opposite pole as oxide according to the amount present. Beneath are a few of the results obtained.

Taken. Fe.	Ni.	Found. Ni.
0·100	0·0990 grm.	0·0995 grm.
0·400	0·0990	0·0985
0·075	0·1315	0·1320
0·333	0·3197	0·3210
0·666	0·3200	0·32075
0·250	0·6550	0·6538

Erdington, June 25, 1887.

ANALYSIS OF VINEGAR.

By B. F. DAVENPORT, late Vinegar Inspector for Boston.

THE following detailed practical method of determining whether a sample of "cider vinegar or apple vinegar" conforms to the requirements of the statute relating thereto, which requires that it should be not only the legitimate and exclusive product of pure apple juice or cider, but also that it should not fall below the quality of possessing an acidity equivalent to the presence of not less than 4½ per cent by weight of absolute, that is monohydrated, acetic acid, and should yield upon full evaporation at the temperature of boiling water not less than 2 per cent by weight of cider vinegar solids, may prove of interest to those dealing in the article. As the limits set by the statute are in per cents by weight, the portion of vinegar taken for the tests should, for perfect accuracy, be also taken by weight, that is the quantities of 6 and of 10 grammes are to be taken for the tests of strength and of residue, but as taking it by measure, if of about the ordinary atmospheric temperature of 60° to 70° F., will make the apparent percentage at most only 1 to 2 per cent of itself greater than the true, that is will make a true 5 per cent vinegar appear to be, say, from 5·05 to 5·10 per cent, measuring proves in practice to be accurate enough for all common commercial purposes, and therefore the quantities of 6 and of 10 cubic centimetres by measure may be taken in place of as many grammes.

All the measuring apparatus necessary for making the legal tests is one of the measuring tubes, called burettes. It is most convenient to have this of a size to contain 25 to 50 c.c., that is cubic centimetres, and have these divided into tenths. The best form of burette is the Mohr's, which is closed by a glass stop-cock. Besides this only a dropping-tube, called a pipette, graduated to deliver 6 and 10 c.c., will be needed. These tubes are to be obtained of any philosophical or chemical apparatus dealer, being articles generally kept in stock by them for common use, like yard sticks.

The only two chemicals needed in determining the strength of a vinegar are such as can be obtained of any competent apothecary in any city of the State. They are simply a small vial of a 1 per cent solution of phenolphthalein in diluted alcohol, and a sufficient quantity of a solution of caustic soda, prepared as directed for "Volumetric Solution of Soda," upon page 399 of the last "U.S. Pharmacopœia," a book which is in the hands of every competent apothecary, as it contains the formulæ according to which he is required by the law of the State to prepare all such medicinal preparations as are mentioned therein.

Having these, the procedure for making the test will be as follows:—Fill the pipette by suction and then quickly close the top of it with the forefinger. Raise the tube out of the sample of vinegar and let it empty out by drops exactly down to the top graduation mark. This bearing the mark of o c.c. Then holding it over a white mug or cup let it run out exactly down to the 6 c.c. mark. Dilute the 6 c.c. of vinegar, thus measured out into the mug, with sufficient clean water to make it look about white, and then add to it about three drops of the phenolphthalein solution. Then, having prepared the burette by filling it up to the top, zero, or any other noted mark of the graduation, with the volumetric solution of soda, let the soda solution run out cautiously into the diluted vinegar, which should be constantly stirred about. As soon as the vinegar in the mug begins to darken the soda should then only be allowed to run into it by drops. This dropping is thus continued until at last a final drop of soda turns the vinegar suddenly to a permanent pink or cherry colour, which will not disappear upon further stirring. By now reading off from the graduations of the burette the number of full c.c. divisions and of tenths which have been emptied out to bring about this change of colour in the vinegar is known the per cents and tenths of acidity equivalent to true acetic acid contained in the vinegar being examined. This, if it is a pure cider vinegar and well made, will be upon the average about 6 per cent, but never under 5 per cent. If in like manner 10 c.c. of the vinegar is exactly measured off by the pipette into a small light porcelain dish, and then evaporated fully to dryness over boiling water, the number of grammes weight gained by the dish, when multiplied by ten gives the percentage of solid residue contained in the vinegar.

There are certain characteristics peculiar to the residue of a pure cider vinegar, the principal of which are the following:—It will be about 3 per cent in weight, and never less than 2 per cent. It is always soft, viscid, of apple flavour, somewhat acid and astringent in taste. A drop of it taken up in a clean loop of platinum or of iron wire and ignited in a colourless Bunsen gas lamp flame, imparts to it the pale lilac colour of a pure potash salt, without any yellow due to sodium being visible. The ignited residue left in the loop of wire will be a fusible bead of quite a good size, and it will leave a strong alkaline reaction upon moistened test-paper, effervescing briskly when immersed in an acid. The presence in a vinegar of the slightest trace of any free mineral acid will prevent the ignited residue leaving any alkaline reaction, or effervescing with acids. The presence of any practical amount of commercial acetic acid added, to "tone up" the strength of the vinegar, will cause the igniting residue to impart another colour to the Bunsen flame, and the residue itself will have a smoky, pyroligneous taste or odour. Any corn glucose used in the vinegar will cause its residue when ignited to emit the characteristic odour of burning corn; and as the last spark glows through the carbonised mass, to usually emit the familiar garlic odour of arsenic. For the common oil of vitriol usually used in the production of glucose is now mostly derived from pyrites, which almost always contain arsenic. A glucose vinegar which has been made without vapourising the alcohol after the fermentation of the glucose will also have a strong reducing action upon a copper salt in an alkaline solution, and also will give a heavy precipitation of lime with ammonium oxalate. A true malt vinegar always contains phosphates, and a wine vinegar cream of tartar. The presence of any acrid vegetable substance in a vinegar is known by the residue having a pungent taste, especially if before the evaporation the vinegar has been exactly neutralised with soda.

In a pure apple cider vinegar hydrogen sulphide gas will not cause any discolouration, nor will the addition of a solution of either barium nitrate, silver nitrate, or ammonium oxalate cause anything more than the very slightest perceptible turbidity. But the addition of some solution of lead acetate—that is, of sugar of lead—will cause an immediate voluminous and flocculent precipitation, which will all settle out in about ten minutes, leaving a clear fluid above. In most of the so-called "apple vinegars" brought into this market from other States the addition of some of this lead solution will cause but a slight turbidity, without any precipitate settling out for several hours, and even then the precipitate will not be of the same appearance as in apple cider vinegar.

Sophistications of cider vinegar that will not be detected by some one or more of the above given tests are not likely to be met with, for the simple reason that they are not profitable. To translate percentages of acid strength into the old commercial terms of grains of soda bicarbonate per troy ounce, the per cent may be multiplied by 6·72; or, *vice versa*, divide the grains by the same factor. To reduce it into grains of potash bicarbonate, 8 would be the factor to be used in like manner.

ON A METHOD OF ILLUSTRATING THE PERIODIC LAW.

By W. SPRING.

In Part 15 (vol. xix.) of the *Berichte* is described a method of illustrating the Periodic Law by J. Emerson Reynolds.

The writer begs to state that he has employed this method for the last six years in his lectures on general chemistry at the University of Liege. For this purpose he has had tables lithographed (Vaillant-Carmanne, of Liege) representing the undulations of the periodic system, and he forwards to the German Chemical Society copies of the first and the second edition of his tables (1881 and 1885).

As it is his intention to develop his method at large, showing that not only the great and small periods but the relative energy of the elements can thus be illustrated, this claim of priority is evidently justified.—*Berichte der Deutschen Chem Gesellschaft* (Vol. xix., p. 3092).

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

June 25th, 1887.

Shelford Bidwell, F.R.S., Vice-President, in the Chair.

The following communications were read:—

"*Note on Magnetic Resistance.*" By Prof. W. E. Ayrton, F.R.S., and Prof. J. Perry, F.R.S.

In the spring of 1886 the authors made experiments on the magnetic induction through horse-shoe electromagnets when excited by constant currents. The inductions through different armatures and air-spaces were also measured. The results show that, for small exciting powers, the law of parallel resistances is true for magnetism, taking leakage into account. From experiments

made with two electro-magnets, the poles of which were placed at different distances apart, the authors conclude that the magnetic resistance of air is proportional to length, or to length plus a constant.

A note on Magnetic Resistance was read before the Society on March 12th, 1887, by the same authors, describing experiments on two iron rings, one whole and the other divided by a radial saw-cut. Since then the experiments have been repeated with great care by Col. Swinton and Mr. Sorënson, of the Central Institution. The resulting curves agree with those previously obtained. On measuring the air-space it was found considerably less than estimated, and the magnetic resistance of air relative to iron (assuming no "surface resistance") comes about 1500. Experiments made with different air-spaces, together with the above, seem to show a considerable "surface resistance."

Prof. S. P. THOMPSON thought dynamo-makers had evidence of such "surface resistance," from the care exercised in avoiding joints in the magnetic circuit wherever possible; and Mr. BOSANQUET mentioned some experiments he had recently made on the resistance of joints during the various stages of fitting. The changes of resistance are very large, and he concludes that, however good the fit, it is not possible to reduce the surface resistance to a negligible quantity.

"*On Sounding Coils.*" By Prof. W. STROUD, D.Sc., and J. WERTHEIMER, B.Sc.

The paper describes experiments on coils and helices of wire which emit sounds when variable electric currents are passed through them. The pitch depends on the frequency of the current variations. The authors believe the sounds due to the attractions of adjacent parts of the wire, which cause shortenings and lengthenings as the current increases or decreases. To prove this two identical coils were made, and one of them embedded in plaster of Paris. This gave no sound when the variable current was passed, whilst the other emitted the usual note. It was also found that no sound could be got from a single turn of wire, whilst one and a quarter turns gave an audible sound under the same conditions.

"*On Comparing Capacities.*" By Mr. E. C. RIMINGTON.

This is an investigation of the conditions under which the integral current, through a galvanometer in a balanced Wheatstone's bridge, is zero, when the battery circuit is broken,—two adjacent arms, A and D, of the bridge being shunted by condensers of capacities, K_1 and K_2. It is shown that—

$$\frac{K_1}{K_2} = \frac{C}{B}$$

where C and B are the resistances of the arms opposite to A and D respectively. If A and D be made infinite the necessity of balancing for steady currents is obviated, but if either of the condensers has an appreciable leakage, corrections are required. The best resistance to give to the galvanometer is shown to be—

$$G = \frac{B(C+D)}{B+C},$$

and the conditions under which a telephone may replace the galvanometer are—

$$\frac{K_1}{K_2} = \frac{C}{B}.$$

The case where all the arms have self-inductions is investigated.

"*On the Effects of Change of Temperature in Twisting or Untwisting Wires which have suffered Permanent Torsion,*" By HERBERT TOMLINSON, B.A.

The author's attention was re-directed to the subject by the note read by Mr. Bosanquet on May 14th. Some eight years ago he made experiments on such wires, and regards the effects due to changes produced in the thermal expansibility of the metals, by permanent elongation or compression. Thus if a small square be drawn on the surface of a wire, and the wire subjected to permanent torsion, the square becomes a rhombus, the longer diagonal of which suffers permanent extension and the shorter diagonal permanent compression. If permanent extension causes an increase in thermal expansibility and compression a decrease, then a rise of temperature will cause the wire to twist more, and *vice versa*. With annealed iron wires which have suffered permanent torsion, remarkable effects take place at about a red heat. In heating such a wire it untwists slightly until a bright red heat is attained, when a sudden twist takes place. On cooling, a sudden untwist occurs at about the same temperature. These effects have been previously observed by Prof. Barrett, who believes them to be connected with the sudden changes in the magnetic properties of iron, and to take place at the same temperature. This latter conclusion was found to be erroneous, for the author exhibited experiments showing that the magnetic change takes place at a temperature decidedly lower than that at which the jerks above referred to occur.

"*On Permanent Magnet Ammeters and Voltmeters of Invariable Sensibility.*" By Prof. W. E. AYRTON, F.R.S., and Prof. J. PERRY, F.R.S.

The sensibility of ordinary permanent magnet ammeters and voltmeters increases as the strength of the magnet decreases, whereas in those of the Depretz D'Arsonval type (in which a suspended coil controlled by torsion swings between the poles of a permanent magnet) the reverse effect takes place. By combining the two systems the authors have devised instruments whose sensibility is unaltered by changes in the strength of the magnet. The torsional control of the D'Arsonval is removed, and a small permanent magnet attached to the swinging coil. As the large permanent magnet changes, the controlling and deflecting forces change in the same proportion, and the deflection for a given current remains unaltered.

UNIVERSITY COLLEGE, LONDON.

CHEMICAL AND PHYSICAL SOCIETY.

DR. WILLIAMSON'S FAREWELL ADDRESS.

THE following Address was given by Professor A. W. WILLIAMSON, F.R.S., at a meeting of the Chemical and Physical Society, on Thursday, June 16th. Prof. William Ramsay, Ph.D., occupied the chair, and a large number of visitors, including Prof. Odling, Dr. W. J. Russell, Dr. George Buchanan, and Prof. Carey Foster, were present.

It is useful now and then to pause in one's work among the multifarious details which commonly engage our attention, and to look somewhat from a distance at the general outline of things which one may have been working at, but more especially at the outlying parts of the country, in one corner of which one may have been working. Of course it is necessary to divide the work of science into many compartments, and it does sometimes happen—I suppose it not unfrequently happens—that for a while one does not look so much at the neighbouring provinces and at the glorious territories which are being developed, as one does at what has been doing in one's immediate vicinity. I think that with regard to chemistry it may perhaps not be less important than in other portions of the domain of science to forget now and then a good many of the multifarious particulars which have been accumulated, and to look a little at the general results which have been arrived at in what I have just now called the neighbouring provinces, and to see how far those results have a bearing upon what we have been doing. And if science is in its nature one, and if we are by degrees to rise to more general conceptions of the order of nature, I conceive that it is not one of the least important operations that one should, from time to time, endeavour to learn the chief bearings of the surrounding

country, and to see how they stand in relation to the landmarks in one's own particular province.

The country which I am thinking of at the present moment as adjacent to chemistry is one between which and the department of chemistry the border line would be difficult to trace. I believe that our forefathers of Great Britain were benefitted by the existence of that debateable land in the north between Scotland and England. When one reads of the daring deeds of those border men, and of the energies which were developed in the practical discussion of questions of boundary with which they were very particularly engaged, one is inclined to think that such exercise of their energies may have been conducive to a development of those energies, and to a benefit to both these districts between which the border-land lay, by raising up men who looked to the one and to the other, and not merely to one. Now, of course, in our work of chemistry we do work at many things which concern the workers in physics, but the general treatment of those subjects is, in some respects, and commonly has been to a great extent, peculiar to them.

Now, amongst our results there is one — if I may be permitted to call it a result—which I venture to think constitutes an important landmark, established by the work of chemists in the advancement of knowledge. It is what is commonly called the atomic theory; and perhaps, in speaking of that, it may be desirable that I should in one word state what I mean by "theory." A scientific theory, I suppose, ought to be the most condensed statement of general facts: and I take it that the atomic theory is that. To me it is nothing more. I do not use atomic reasoning, or refer to considerations relating to the atomic operations, otherwise than as indicating limits which exist to our efforts to break up matter. Whether we like them or not they exist. There are many thinkers who prefer overstepping that boundary, and discussing aloud, as well as considering silently, what there may be beyond it — whether, for instance, these limits by which we are stopped at present, and which I think that it is well to recognise as existing in our present state of knowledge, may not be overstepped. As a chemist I have nothing to do with that. There is a border-land which is, perhaps, like the other border-land of which I have spoken. Its existence is not only natural, but may possibly be useful. I am far from deprecating the exercises which are not strictly scientific, which are not based upon actual well-established facts and reasonings, and which are not conducted on the most rigorously irreproachable method—reasonings, in fact, in which the imagination plays a somewhat greater part than it does in the ordinary routine of scientific work. And therefore, when I say that as a chemist I have nothing to do with speculations as to the decomposition of atoms, I merely wish to recall what I conceive to be the real solid ground upon which by generalisation the atomic theory stands.

Now, whilst we chemists have been working away (and the number of us who are working at it is marvellously great and wonderfully increasing) at examining chemical changes and putting on record new observations which have been elicited by carefully-conducted experiments regarding those chemical changes, there have been others who have taken up many of the results at which we have arrived, and have considered them from a point of view with which we, as chemists are, I may say, scarcely at all occupied. Of course the chemist may know something more than chemistry, and in most cases it is very desirable —perhaps more than desirable—that he should do so. But I mean that in his purely chemical work he has not to do with determinations of the kind which in physics constitute essential results—in fact, the main body of the work. And amongst these results there is one which certainly is exceedingly prominent, and amongst the recent triumphs of the human intellect, and the careful, methodical work of science, certainly not one of the least noteworthy. It is that the physicists have taken particular cognisance and have begun the careful study of certain groups or clusters of atoms which we have noticed and described, and regarding which we have establish various important facts.

Now I think that it is fair to acknowledge, with regard to our brethren in the neighbouring province of physics, that it is to them that we owe mostly the study of the motion of these clusters of atoms as I have called them. But I ought perhaps to call them, to adopt the common term, molecules.

The knowledge of certain very simple laws appertaining to that motion is a triumph of work in physics of which this generation may justly be proud. I do not think that I am wrong in saying that the fact of their moving, and the bearing upon other truths of that circumstance, has not as yet occupied as much of the attention of chemists and of other workers as I venture to think it may be destined to occupy from its natural importance and from its fundamental character.

Chemists have had occasion to study and are still studying cases in which individual atoms move; indeed most of the chemical reactions which they examine are proved to be due to interchange of atoms between molecules. Take any one of the very simplest of chemical reactions you like. Take the precipitation of a silver salt by a soluble chloride. Noting merely the most elementary facts regarding those substances we observe that when we mix them in a fluid so that they can act upon one another conveniently a change of place occurs between one kind of matter and another kind of matter—between the silver in the one compound and the metal in the other. They change places.

One of the first and most fruitful sources of our information about elementary atoms was the consideration of the relative weights of the different kinds of matter which thus change places.

Not a year passes without a great number of new compounds being made by the assiduous labours of skilled experimentalists. Brief outlines of these researches annually fill an enormous volume. Most of these compounds are made by processes of atomic interchange between molecules, or of the interchange of groups of atoms which behave like individual atoms—in fact, by processes of atomic motion.

It was stated long ago by Berthollet that when two salts in solution are capable by interchange of constituents of forming a precipitate, such interchange takes place and the precipitate is formed.

The point is of some importance, and therefore perhaps it might be well that I put it not only in that way, but in some other which I will endeavour to find so as to make sure that we have the conception clearly before us. The formation of a precipitate was stated—and *primâ facie* very reasonably stated—to be a test of whether the particles could move so as to form it. Thus, if by interchanging their metals, for instance, two salts in solution would form some insoluble body, then we might be sure that such interchange would take place. Now this statement is true with exception of certain rare cases where circumstances interfere with the process; and certainly any statement which thus connects a vast number of phenomena, and which does correctly correspond in the main with the realities with which it professes to deal, must be of some considerable value. But another circumstance about it is that a cause was invented to explain this regularity. An interchange which produces a precipitate was supposed to be due to an inherent force in the materials to move in such manner if by so doing they could form a precipitate. This inherent force was called "pre-disposing affinity." It has often happened that those who discovered some regularity in nature previously unknown have thought to explain it by supposing some special force to have been at work, and have invented a name to describe the imaginary force. So in the earlier stages of civilisation men endeavoured to explain the occurrences of nature by supposing external objects to be endowed with will and power of discrimination.

The term "predisposing affinity" implies that the particles were in some way predisposed to do this particular thing which they were found to do. I think that the term conveys that idea, and can hardly be separated from it. On reflecting upon the state of such particles which are "predisposed," and following out rigorously the idea which is thus suggested, I must confess that I have felt at a loss to know how the particles could judge of the cases in which their disposition could find vent, and distinguish them from the other cases in which their best intentions would not bring about such a result. Take the case of the chlorine and the silver in the two compounds which I have mentioned. If they are "predisposed" to combine, they can only do it if they form a precipitate; and how are they to know that the compound will be insoluble? I have heard it compared to a game which I suppose that most of us have played in our youth—the game of "puss in the corner." The change of place that takes place between two of the moving atoms—if you will allow me to call them so—is the result of some interchange of symbols. "Will you change place with me, for if so, I am ready to change with you." But in the case of the chemical reaction there would need to be something more than that. There would need to be some valid ground for believing that a result of a particular kind would ensue from the change of place if it occurred.

It would, however, be remarkable that particles should only move in this manner under the particular conditions indicated by the general law. Those who have paid even slight but careful attention to the elementary facts of physics are aware that there are a great number of circumstances which cause a communication of motion or vibration to matter in its various forms. Thus the molecules of liquids, even when apparently at rest and in a state in which they undergo no change—are in a state of constant motion. The phenomena of liquid diffusion afford an illustration of such molecular motion. These phenomena do not, however, afford us any direct evidence of the interchange of atoms between molecules.

Perhaps it may be convenient that I should allude next to a simple case which is now well known to chemists. I shall not go beyond the most elementary commonplace facts, because they afford the surest footing for generalisation.

There is a group of atoms called ethyl which in its chemical behaviour was long known to be very much like a single atom. It was very much like hydrogen in its nature, and it has been shown by very simple and direct experiments which are not at all difficult to verify that when a compound of ethyl—the particular compound called alcohol—is mixed with a hydrogen compound, also fluid, called oil of vitriol, the two bodies do not continue unchanged while in contact with one another. The atoms of ethyl in the alcohol change places with the atoms of hydrogen in the oil of vitriol. There is no precipitate formed. It is a case in which there is a movement, a change of place, of the same kind as that which in the class of phenomena I was alluding to would have produced a precipitate.

The atomic motion is the same, but it takes place certainly without that "predisposing" cause. It is, moreover equally well known that when we have water and sulphovinic acid (the products of the atomic interchange just mentioned) mixed with one another, an interchange of ethyl with hydrogen takes place between those compounds producing alcohol and oil of vitriol. Alcohol and oil of vitriol by an atomic interchange between ethyl and hydrogen form water and sulphovinic acid; these products by interchange of hydrogen and ethyl reproduce alcohol and oil of vitriol.

In these cases we have not indication of atomic motion such as are afforded by the formation of precipitate, or by any other visible sign. The atomic interchanges are only proved to have occurred by careful chemical investigation.

These cases in themselves prove that atomic interchange between molecules are not confined to reactions like those in which they were previously recognised. There are many other cases in which chemical investigation has enabled us to determine the state of combination of the constituents of molecules similarly present in a mixture which shows no external indications of change, and in all these cases, as far as I know, it is proved that similar atomic interchanges occur.

In the study of natural phenomena a similar order in the development of our knowledge has often occurred. It happened in geology that men attributed to exceptional influences the occurrence of changes of a very striking and permanent character; and it is, of course, well known that that truly great philosopher Lyell had the merit of showing that all those known changes were the result of quiet processes of gradual change which were constantly going on, sometimes more rapidly then at other times, and were due to continuous action of the forces of nature. Then, again, with regard to biology, we have had of recent years a perfectly similar result before us. Instead of supposing, as we did, that exceptional circumstances caused the occurrence of particular species and of varieties in the animal and in the vegetable kingdom, we now know these great differences are the result of that silent and continuous action of the natural life processes as influenced by external conditions.

In each of these cases the prominent phenomena which first attracted attention were ascribed to the occasional and spasmodic action of special influences, but further investigation showed them to result from the nominal action of influences which were continuously at work. Atomic interchanges between molecules were known to take place in cases where their results showed themselves prominently and readily, and were attributed to predisposing affinity which caused their occurrence in these particular cases.

We now know that atomic interchanges take place without giving any indications of the kind previously noticed. In illustration of the variety of cases of such interchanges of which chemical evidence has been obtained a few cases may be given beyond those already mentioned.

Thus, a solution of potassic hydrate in alcohol contains potassic ethylate and water, as proved by various tests, and reciprocally a solution of potassic ethylate and water contains alcohol and potassic hydrate.

A solution of chlorine in water is proved by many of its properties and reactions to contain hydric chloride and hydric hypochlorite, and reciprocally, a mixture of the concentrated solutions of those bodies is partially decomposed with formation of chlorine and water.

When the products formed by the interaction of liquid substances happen to be themselves liquid, it has been pointed out that we find that by the reaction upon one another of these products the original materials are reproduced as fast as they are decomposed, and the equalisation in the composition of the mixture is established, but when one or both of the products happens to be solid, and consequently unable to react readily, if at all, upon the other product, this reproducing change does not occur, and the decomposing change completes itself.

To make it more clear I may be permitted to give a little more precise statement, so as to avoid any possible mistake. I may take for that purpose, say a potassium salt and hydrogen compound. Suppose that we have common saltpetre—nitrate of potash—and hydrochloric acid. I say that when they are present the potassium in the one compound does change places with the hydrogen in the other, forming hydric nitrate and potassic chloride. And those two salts, like any other salts, when they are present also interchange reproducing the original materials, so that there is going on in such a mixture, not only a process of what I may call decomposition and change, but also a reproducing process. That is what occurs when, as in the case which I have mentioned, the products which are formed by the decomposing change remain

fluid and are able to interchange the particles back again so as to reproduce the original materials.

The next point is that when we have got these products changed they have got properties of the same kind. In contact with one another they undergo a similar process. The atoms change places naturally and reproduce the original compounds. But if, as in the case which I first took, we happened to have taken two compounds of a kind which could not form a soluble body, but which formed an insoluble one, as in the case of the silver salt and the hydric chloride, then this decomposing change would take place; but the silver, when it got into juxtaposition or intimate contact with the chlorine, would form a compound which is insoluble, which cannot dissolve in the liquid. And so it falls to the bottom, so that it does not come in contact with the other compound; and even if it had a predisposing affinity to form the original compound again, it would not be able to do it. The formation of precipitates presents itself, according to this more general conception, as the result in those particular cases in which one or more of the products which are made happen to be of such a kind that they pass out of the sphere of action of the other compounds. It is one result of a process which occurs in all cases of chemical reaction, the result of a uniform influence which is not peculiar to those cases.

I should like to give, if you will permit me, one or two other very elementary cases which are noteworthy, because they do not strike one, and they are not so much in the ordinary course of elementary testing. They have, perhaps, a peculiar interest as showing how the principle applies itself to cases somewhat different in form. And that brings me to the consideration of the condition of substances when they are dissolved. We are accustomed, and, I think, naturally enough accustomed, in the first instance, when we have no evidence to the contrary, to suppose that if we dissolve any particular substance in water the substance is there—that the same substance which was put into the water is there, and that the water is also there.

One does not, for instance, feel any motive or any ground for imagining that in the process of solution they have undergone change. One of the commonest cases of the kind is the case of chlorine gas. Chlorine is one of the commonest and best known of elementary gases, and when it is dissolved in water it is well known to possess properties which chlorine itself does not possess. For instance, chlorine may be brought into contact with a colouring matter called litmus, without any change taking place. For some time I had a jar which was kept closed, and contained very dry chlorine. There was a piece of blue litmus in it, and the litmus retained its blue colour, for I do not know how many years, until in process of time the jar got a little leaky and a little moisture leaked in, and the litmus gradually lost its colour. The chlorine in the presence of the moisture produced that effect which does not belong to chlorine itself. In like manner it is well known that chlorine itself does not produce various other effects which its mixture with water produces. For instance, if you shake up chlorine with water containing carbonate of lime—chalk—we find that an action takes place in which the chlorine behaves in two ways. Part of the chlorine passes one way and forms one compound, and another part of the chlorine—precisely half of it—passes another way and forms an entirely different compound. Now I think that to anybody—even to those who have not attended particularly to chemical phenomena—it would seem strange that if you pass chlorine gas, which is homogeneous, into a mixture, one-half of it behaves in an entirely different manner from the other half. An analysis of the process has shown that the result is due to this fact, that the chlorine in the presence of water is reacting on the water. We know that chlorine—I am not now expressing any opinion, but merely a fact perfectly familiar to all chemists—the so-called free chlorine consists of a cluster of two atoms united together—combined chemically. The smallest quantity which we could get would be a couple of atoms linked together.

$$\begin{array}{c|c} Cl & Cl \\ H & OH \end{array}$$

This chlorine, when it is in contact with water, consists in part of these two products which I have marked off by the dividing line. One-half of the chlorine is in combination with an atom of the water and has taken it out, and the other part of the chlorine has passed into combination with those elements with which that atom of hydrogen was combined. I think that we may as well describe it as an atomic interchange. It is merely a difference in form. I have represented it by a dividing line. It is a substitution in which you have got all the so-called element which we recognised some years since to consist of a couple of atoms united together. When we have got them in contact with water, an interchange goes on between half the chlorine in many of those atoms of chlorine and many of the atoms of the hydrogen in the water.

But that is not all. I gave another illustration just now. The power of this liquid to dissolve carbonate of lime is a property which does not belong to chlorine by itself. It belongs to the hydric chloride, which is formed in this manner according to the interchanges which I have indicated. That fact that this chlorine in water absorbs chalk, and forms the compound which hydrochloric acid forms with the chalk, shows that hydrochloric acid is there. And then we find also as a product the peculiar bleaching body, of which the formula is HClO.

This is the other part of the reaction which I have previously mentioned. I mean that it is this which causes chlorine in the presence of water to bleach.

I ought, however, in order to supplement this statement, to give the counterpart of it, because I think that you will probably have perceived, although I did not expressly state it, that if you bring two substances together, and if the decomposing change were to go on and not to be balanced by something else, the whole substance would be decomposed, and not a part of it. For instance, in the case I took of the alcohol and the oil of vitriol, we do not find that ethyl and hydrogen all of them change places. We find that certain proportions of them change places. And it depends on how much you have of the sulphuric acid and how much of the alcohol, what that proportion is; whereas if there were only a tendency to interchange in that one direction, so as to decompose the substances originally put in, then the decomposition would complete itself, and you would have no ethyl left—at all events, those atoms which were present in the smallest number would disappear from the compound in which they were. But what we do find is that in each case of the kind there is a certain balance. When once the decomposition or the atomic interchange has gone a certain way, then it goes no farther. There is no greater quantity of either product formed on longer standing. Not only do those materials react on one another and cause a decomposing change to take place, but that the products when they are formed, also react on one another, and cause a reproducing change to take place.

Thus, when you take a mixture of chlorine and water, in which by experiment you find that a definite proportion of the molecules of chlorine and water have reacted on each other in the manner described; this equilibrium is due to the fact that in each unit of time as many molecules of the materials are decomposed (by the mutual interchange of atoms) as are reproduced by the corresponding interchange of atoms between the molecules of the products.

I take this particular case, but I might adduce many other similar cases. That there is such constancy as soon as the particles have been together long enough to have had time to arrive at that equilibrium, is an elementary fact which is a matter of experiment. A great many cases of anomalous results become clear. In my own small experience I may mention some things which seemed to

look certainly remarkable and inexplicable until I looked at them in the light of this process, which, I believe, is of universal occurrence, and certainly no limit to it has been assigned. For instance, take the case of alcohol. Organic bodies have the advantage that the interchange is slower, and it is more easy to arrest the products formed by them without their changing back again, so that we can catch them in the state in which they were. The very illustrious French chemist, Balard, was a man remarkable for his loyalty, and the incident which I am about to relate is certainly typical of that. One dwells with pleasure upon it. Balard made an experiment for the purpose of preparing a particular body combined with an organic radical called amyl. He thought that he would get the oxide of amyl, and the process which he adopted was, according to the ideas which then prevailed, an exceedingly reasonable one, and one which could hardly have failed, if those ideas had been correct, to lead to the result in question. He dissolved potash in alcohol, and he treated the solution with the chloride of amyl, and he thought, according to the idea that then prevailed, that potash was simply an oxide of potassium, and that when it was dissolved in alcohol it ought to be oxide of potassium and was not combined with the alcohol in any way. Well, he get a body which was perfectly different. He burnt it, he analysed it, and he has published the results of his analysis, which did not agree, even approximately, with his anticipation. Afterwards, attention was drawn to the fact that the solution of potash in alcohol did contain the potassic hydrate which had been put into it, but it also contained a compound (C_2H_5OK) formed by the atomic interchange between the potassium of this potassic hydrate (HOK) and hydrogen of the alcohol (C_2H_5OH); and it is this compound that is acted upon by the chloride of amyl. It is well known that if you pass carbonic acid into it you get a compound of it with the carbonic acid. You get a compound of it with the potash because there is always some of the potash left, but you also get a compound (carbovinate) of the carbonic acid with the potassium-alcohol.

I have given this case, and it would be wearying you, I think, if I were to go into many other such cases. There would be a great sameness in the results which they afford. But as far as I know, whenever we have the means of ascertaining the condition in which substances are present in solution, we find evidences of such atomic interchanges. I do not know a single case in which, from a wider view of things, one can affirm that it is not so.

It may be desirable to test the generality of the law by briefly considering some simple cases of aqueous solution of salts. I do not think that it would be reasonable to expect one to be able at once to show the application of a new theory to all the cases to which one would conceive it applicable. Careful and prolonged study is required to work out its application in the various forms which present themselves. Common salt when dissolved in water must be expected to be present partly in the form of the salt and water—partly in the form of products formed by the interchange between the salt and the water with which it is in contact.

I feel convinced that when salt dissolves in water there is going on between the constituent atoms, the sodium atoms in the salt and the hydrogen atoms in the water, an interchange forming hydric chloride and sodic hydrate, and that there is also going on an interchange between the corresponding atoms of those products which is reproducing the original substances. Now if, as in that case, the substances which you mix are of very stable equilibrium, little prone to undergo change, then we should expect from the general law to find that the number of molecules of the original salt and water present must be enormously great compared to the number of molecules of the products formed by their mutual reaction, because these materials react very slowly on one another, so stable are they; and in order to form in a unit of time the given number of the products equal to those that are formed by the reproduction they must be present in great numbers compared with the other. Thus if, when the composition of the mixture has become constant there were a thousand times as many molecules of the materials (salt and water) in solution as of the products of their mutual reaction (sodic hydrate and hydric chloride), then there are in a unit of time as many decomposing interchanges between a thousand molecules of salt and water as there are of reproducing interchanges between one molecule of sodic hydrate and hydric chloride; or what is the same thing, the acid and basic substances react a thousand times as fast as salt and water.

In order to understand the chemical behaviour of particular substances it is always desirable not to limit one's view to any one of them, but, as far as possible, to group together with its substances which we know to possess a close analogy to it. Compounds of ammonium are known to possess a close analogy with those of potassium. Ammonic chloride dissolved in water must be in the main like, and must obey the same law, and could not be expected to be in its nature different from potassic chloride. The solution is found to contain the products of the action of the salt on water, for by mere boiling the ammonic hydrate that is in it gives off ammonia gas, and hydric chloride is left in the solution. Another well-known salt, magnesic chloride, when dissolved in water, forms a solution which appears homogeneous, and presents no external indication of containing any products formed by atomic interchange; yet the water cannot be driven off so as to leave the salt, for it is well known that hydrochloric acid which is present in the solution passes off with the vapour of water, leaving a basic salt.

Again, take ferric chloride; here we have evidence that nearly all the chlorine in the salt passes off in the form of hydric chloride, leaving ferric oxide mixed with a little of the salt. Again, there are other cases in which we are not accustomed to consider that the salt dissolves at all. Yet in their essential features they are processes like those in which we do. For instance, there is a liquid chloride of phosphorus which, when we throw it into water, acts with great violence. It is in its constitution like chloride of antimony, and, like many other chlorides which we are in the habit of speaking of as dissolving as such; yet we note with regard to it that the water contains chiefly the products of interchange with water. In fact, when we evaporate we cannot recover any of the original material. In considering these phenomena it ought not to be forgotten the decomposition of substances is the process commonly resorted to in order to render them soluble—bone earth is dissolved by hydric chloride by a process of decomposition; lead sulphate is dissolved by potash in like manner. Chemistry abounds with similar examples. I have only mentioned these few cases in order to afford illustrations of what I believe to be a general truth, that if, instead of confining our attention to the facts before us in one particular case, like that of the solution of potassic chloride with water, we take a wider horizon and consider, side by side with that, what occurs in the case of bodies different in their composition, but analogous in their general nature, we get clear and unmistakable evidences of that fundamental process which I affirm takes place in all, and it would be difficult to suppose that solution of the potassium salt takes place by an entirely different process to that which is found to occur in other cases.

Professor Ramsay and Professor Carey Foster proposed a vote of thanks to Professor Williamson.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, July 4, 1887.

Henry Pollock, Esq., Treasurer and Vice-President, in the Chair.

The following gentlemen were elected Members:—Henry Davey and Harry Robert Graham.

The special thanks of the Members were returned for the following donation to the fund for the promotion of experimental research :—Ludwig Mond, £100.

The presents received since the last meeting were laid on the table, and the thanks of the Members returned for the same.

NOTICES OF BOOKS.

Pneumatics, including Acoustics and the Phenomena of Wind Currents. By Charles Tomlinson, F.R.S. London: Crosby Lockwood and Co. 1887. Fourth Edition.

The study of the atmosphere is one which must, from its very nature, be always carried on under circumstances different from those which attend research of any other kind. The atmosphere is invisible, it has no colour or smell. We can hardly say with reason that it affects our sense of touch, while a further disadvantage exists in the fact that we are unable to get out of it, and thus study it from the exterior. In all other branches of research we have to deal with substances or phenomena that we can either see, hear, weigh, or manipulate in some manner or another; but in this case we even go so far as to say that a vessel is empty if it contains nothing but air or any similar gas, showing that for long generations the atmosphere was popularly considered as nothing. Towards the close of the last century air was proved to consist of two gases possessed of distinct chemical properties, and from that time, we may say, nearly all our knowledge of its chemical, physical, and meteorological properties has been acquired. The most important instrument used in the study of pneumatics is the barometer, and in the book now before us we find its construction and use very completely described.

The height of the barometer is now intimately connected in our minds with the state of the weather, but many people fall into the error of thinking that a rise or fall indicates simply a wet or fine day, whereas it much more frequently points to the force and perhaps the direction of the wind; and even then we must often be in a state of uncertainty, as we can see from the discussion on the direction and causes of the trade winds, where Mr. Tomlinson tells us that in the West Indies they are inappreciable above the level of 3000 feet, and that a current in the opposite direction is met with at about 12,000 feet. An illustration of this is to be found in the volcanic eruption at St. Vincent in 1812, when the ashes were carried for a great distance in the opposite direction to the trade wind blowing at the sea level.

After devoting a good many pages to these and similar questions, we find the subject of vibrations of the air, or *acoustics*, briefly dealt with; while again, in the appendix, we come to a further study of the wind, with descriptions and illustrations of anemometers, and methods of using and applying them. In conclusion there is a short note on Sprengel's well-known air-pump, which has been, and is now, of such great value, not only in the laboratory but commercially, in the manufacture of incandescent lamps. The book is No. 12 of Weale's Rudimentary Series, and will no doubt be read with both profit and pleasure by those into whose hands it falls.

The Commonhealth. A Series of Essays on Health and Felicity for Everyday Readers. By B. W. Richardson, M.D., F.R.S. London: Longmans, Green, and Co. 1887.

The commonest question, one that is asked millions of times daily, is one that is answered incorrectly more often than any other. We refer to the everyday greeting, "How do you do?" So few people are, or ever have been, actually quite healthy, that their usual answer, "Quite well, thank you," is excusable on the ground that it is comparative. They are better than they were last week or yesterday. That really good health should be so rare to find is the greatest blot on our vaunted civilisation. Nearly all our habits, our dress, our food, and our manner of life tend to injure our health. In our earliest childhood we are accustomed to be insufficiently clothed, because it is said to look pretty to see a baby with short sleeves and bare legs and chest; we are often improperly fed, through ignorance; and not unfrequently subjected to severe frights and shocks to the nervous system, the effects of which can never be got rid of, through a mistaken idea of the way to correct or even amuse a child. The result of this early treatment is to be found in the death rate, which shows that a large proportion of deaths are those of children under four years. Modern medical science is doing all it can to save life and alleviate suffering, but does it cure disease? Those so-called noble institutions, our hospitals, keep alive and send out into the world thousands of persons who will marry though quite unfit, and thus contribute towards the deterioration of the race, while our healthiest men are continually being killed by accidents, by war, and by shipwreck. But do hospitals cure disease? We do not think so. This can hardly be put too strongly. Our modern system is based purely on individualism, while we totally ignore its probable effect on generations to follow. How can this be put right? It is to be done by paying more attention to our daily lives, by taking real care of our children, so that they may grow up really healthy and more fit to be the parents of the next generation. Whoever heard of a trainer of racehorses sending out a young horse in cold weather without proper covering to "harden it;" but this is done every day to thousands of human beings. Dr. Richardson's work on this matter is one of extreme importance. He points out numbers of little things to be done or left undone, of which every one will admit the truth.

Recreation is as necessary to health as food and clothing, but what is play for one would be hard work for another. To be really effective recreation must be a complete change, so that a new set of faculties is brought into use. When possible recreation and education should be combined, and severe strains on the mind, such as cramming for examinations, cannot be too strongly condemned. In the chapter on "Dress in Relation to Heath," Dr. Richardson gives a great deal of sound advice, and suggests modifications in clothing, especially in that of the gentler sex, which may easily be followed without any alteration in outward appearance, so that the charge of eccentricity cannot be urged as an excuse for their non-adoption. When we think of the modern style of female attire we cannot suppress the thought that it is a case of the survival of the unfittest. Pressure is exerted on nearly every part of the body which should be left free in its movements. The lungs and heart have often been displaced by tight-lacing, and varicose veins have often been brought on, or aggravated when already existing, by the use of garters. Male attire is much in advance of that of the other sex from a hygienic point of view; all parts of the body are equally covered, the waist is not used as a support for innumerable layers of clinging garments, which impede the free movements of the legs without really clothing them. We can even find good in the much abused "tall hat." When properly fitted it is not uncomfortable, and, moreover, it acts as a cooling chamber for the head, enclosing as it does a supply of air which can constantly be changed. Its principal fault lies in its colour—it should be grey instead of black. Do not let it be supposed from these remarks that Dr. Richardson advocates for ladies such an enormity as the divided skirt or any other quasi imitation of masculine attire; far from it. He would not have the outward style of female dress altered one bit, but simply some of the details and manners of wearing the different garments.

The latter part of the title is a well-chosen one. This

volume should indeed be in the hands of "everyday readers." In fact, if it were read in every school it could not fail to do great good in improving the welfare of the human race, which should be, if it is not always, the ultimate end of all scientific work.

A Manual of Weights and Measures, with Rules and Tables. By Oscar Oldberg. Second Edition. Chicago: Chas. J. Johnson. 1887.

A knowledge of figures, weights, and measures is one of the earliest and most important acquirements of the human race, and it is a curious fact that among civilised races the language of figures is practically universal. But with regard to weights and measures we are not so fortunate: with the exception of those countries which have adopted the metric system there are hardly two which agree even approximately. In a table showing this diversity we find that the weight of the pound in grammes varies in different countries from 500 to 214·25, with about twenty-five intermediate values. Again, even in England, some pounds are divided into 12 and others into 16 ounces; some ounces into 8 drachms, but one into 16, &c. Reform is certainly wanted, and many suggestions have been made; but we are afraid national pride has a great deal to do with the slow progress made in this direction. Mr. Oldberg lays great stress on the inconvenience arising from this want of uniformity, and enumerates the proposals which have from time to time been made to correct it.

As a book of reference this volume will be of very great service, containing as it does tables for the conversion of any unit into any other of the same class.

Journal of the College of Science, Imperial University, Japan. Vol. i., Parts 1 and 2. Published by the University, Tokyo. 1886 and 1887.

Up to the time of the issue of the first number of this Journal all memoirs and notes of work done in the University were published separately, but as some—though interesting in themselves—were not considered sufficiently important for separate publication, they were, so to speak, lost to science. As time went on it was found that more and more good work was being done, and it has at last been decided to publish this Journal regularly. This is a very important step for the Tokyo University to take, and one that will have the good wishes of all the scientific world.

The Journal is to be printed in English, French, or German, at the option of the writer of each article or communication.

The first paper in No. 1 is "On the Life History of *Ugimya sericaria*, Rond." This is a parasite which infests the silkworms in Japan, doing immense damage, sometimes as many as 70 or 80 per cent of the worms being attacked by it. The author of this paper has examined the subject in a most careful manner, and has prepared six excellent plates illustrating the various parts of the parasite and the phases of its development as seen through the microscope.

Then follows a paper on *Distoma endemicum*, a parasite which attacks the liver of the natives of Japan. Its life history has been studied with the same care as that of the other parasite just referred to.

Other notes—on earthquake diagrams obtained at Tokyo, on the deformation of metal plates in polishing, &c., &c.—complete the first part of vol. i.

The second part is devoted entirely to a long paper on the "Movements of the Earth's Atmosphere and Whirlwinds."

Annuaire pour l'Année 1887. Paris: G. Chamerot.

We have received the above-named pocket book from the Société d'Encouragement pour l'Industrie Nationale. It contains a calendar for the year and a list of the council and members up to date; also the names of the recipients of the Society's medals for last year. It is a handy little volume for those interested in the Society.

Short Report on the Activity of the Imperial and Royal Chemico-Physiological Experimental Station for the Cultivation of Wine and Fruits at Klosterneuberg, near Vienna, during the Years 1881-1885. (Kurzer Bericht über die Thätigkeit der K.K. Chemisch-Physiologischen Versuchsstation für Wein- und Obst-Bau zu Klosterneuburg bei Wien, während der Jahre 1881-1885.)

This institution has been by no means inactive; 2403 investigations have been carried on, involving 19,031 determinations. The substances examined besides wines have included brandy, rum, liqueurs, and fruit wines; vinegar, yeasts, argol, and tartrates; samples of sugar and glycerin, colouring and flavouring-matters used for wines, gelatin, isinglass, &c.; oils, waxes, and honey; waters, cattle-foods, manures, and industrial refuse, soils, rocks, and metals; samples of sumach, insecticides, &c. The authors remark that not a single case has occurred of an Austrian wine sold abroad having been found adulterated.

The effects of coal-tar products and salicylic acid added to wines have been studied, but the results are not here given.

The question of the addition to wines of starch-sugar—a more honest name than grape-sugar—has excited much attention. It is found that in the different samples of this sugar there are present from 13 to 17·5 per cent of matter incapable of fermentation, and in potato sugar syrups from 40 to 46 per cent. If it is permitted to add such sugars and syrups to must before fermentation, then the wines will contain a proportion of matter totally unlike anything occurring in natural wines, even if it should not be injurious to health.

It appears that bilberry wines are coming into use in Germany. They are prepared by adding a solution of sugar to the juice of the berries and allowing the liquid to ferment.

The use of foreign colouring-matters, especially of the injurious oxy-azo colours, is much more common in liqueurs than in wines.

As regards the food constituents of the vine, it appears that manganese must be regarded as essential. The yield of grapes from vines dressed with farm-yard manure was found lower almost by 50 per cent. than from those treated with potassium chloride and ammonium sulphate.

We are sorry to learn that the ravages of the phylloxera are still extending, and that the results of most of the proposed remedies are negative.

The olive trees of South Dalmatia are suffering both from fungi and from insects. It seems impossible to restrain the Dalmatian peasantry, and even the local authorities, from making war against insectivorous birds. The investigations carried on at Klosterneuburg and elsewhere prove how impotent man is against his worst enemies.

CORRESPONDENCE.

SOFTENING MAGNESIAN WATERS.

To the Editor of the Chemical News.

Sir,—Mr. Thomas T. P. Bruce Warren's letter is misleading. The point in dispute between Dr. Frankland, Sen., and myself is not whether — or how much — can Sudbrook water be softened by Clark's process. We agree that the initial hardness is about 28 degrees, and that by Clark's process the hardness may be brought down to 9½ degrees.

We differ as to the composition of the softened water. Dr. Frankland maintained that the magnesia remained almost intact. I, on the other hand, who have learned that solutions of magnesian salts are decomposed by lime-water so as to yield a precipitate of the almost absolutely insoluble hydrate of magnesia, maintained that the softened water must be almost devoid of magnesia.

I have verified my assertion by softening the Sudbrook water and then analysing the softened water. In one experiment I found 1·2 grains, and in another experiment 1·5 grains of magnesia in a gallon of Sudbrook water.

Mr. Warren has not ventured to deny the correctness of that result.

My conclusion, which will be shared by chemists, is that magnesian waters offer no special obstacles to Clark's process. That Clark's process only removes the lime in so far as the lime is present as carbonate, has not been in dispute. To me the Sudbrook water is interesting, as affording an excellent illustration of the correctness of the theory of softening, as set forth by me.—I am, &c.,

J. Alfred Wanklyn.

July 4, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 23, June 6, 1887.

Researches on the Density of Sulphurous Acid and of a Saturated Vapour.—L. Cailletet and E. Mathias.—The critical point of the sulphurous acid, the purity of which had been carefully ascertained, was + 156°, that is a little higher than +155·4°, as found by M. Sajotchewsky. The densities are represented graphically.

Combustion-Heats.—MM. Berthelot and Recoura.—In this paper the authors give the combustion-heats of glucose, quinone, naphthaline, benzoic and salicylic acids.

Combustion-Heats.—MM. Berthelot and Louguinine.—The determinations in the present paper refer to naphthaline, phenol, benzoic acid, cuminic acid, quinone, hydroquinone and pyrogallol.

Alteration-Products of Certain Alloys in Contact with Acids.—H. Debray.—Alloys of tin and of the platinum metals are attacked by hydrochloric acid. That of platinum and tin ($PtSn_4$) in contact with hydrochloric acid diluted with 10 vols. of water is slowly attacked, and, after contact for some days, is converted into blackish scales of the aspect of graphite. This transformation takes place instantaneously with concentrated acid, even in the cold, and with dilute acid in heat. The same products are obtained by attacking a regulus of tin containing platinum with strong or boiling hydrochloric acid. If the proportion of platinum forms one-fifth of the alloy concentrated hot acid must be used. Alloys containing rhodium, iridium, or ruthenium are less easily attacked by hydrochloric acid. It might seem that these graphite-like residues should contain merely the precious metal alone or alloyed with a proportion of tin. But all are found to contain a notable proportion of oxygen and of water. They behave like platinum black in a current of hydrogen, and they determine the explosion of detonating mixtures.

The Solubility of Copper Sulphate.—A. Etard.—The solubility of copper sulphate from − 2° to + 105° may be represented by two right lines which meet at or near 55°. At 103° to 105° the solubility undergoes a third modification. Between 105° and 190° the solubility decreases proportionately to the rise of temperature. The fact known concerning sodium sulphate is merely a particular case of a more general law. This fact seems connected with the bibasic function of acids.

Red Fluorescence of Chromiferous Gallium Oxide. Lecoq de Boisbaudran.—The red fluorescence given by chromiferous gallia in the vacuum tube has now been found to exhibit a very distinct linear ray; its position is $\lambda = 689{\cdot}7$ to $689{\cdot}8$.

Schweitzer's Liquid and Ammoniacal Solution of Copper.—H. Baubigny.—In order to prepare Schweitzer's reagent, the most rational method is to precipitate the solution of a copper salt with the theoretical quantity of soda, and to re-dissolve the hydroxide in ammonia.

On Cyano-Acetic Acid. — Louis Henry. — Cyano-acetic acid is easily split up, especially under the action of heat, into carbon-dioxide and acetonitrile. Its derivatives will probably behave in a similar manner. The acid may be obtained in well-defined crystals, perfectly white. This body does not melt at 55°, as it is asserted by M. Van t'Hoff, but at 65° to 66°.

Action of Ammonia upon Certain Chloro-derivatives of Ethane; Direct Fixation of the Elements of Ammonia upon Non-saturated Compounds.—M. Engel.—In this paper the author has studied the action of ammonia upon vinyle chloride, ethylene chloro-iodide, and chlorised ethylene chloride.

On Percolated Isoamyl-sebacic and Butyl-sebacic Ethers.— M. Gehring.— This paper is not adapted for useful abstraction.

On Cyanacetic Ether.—Alb. Haller.—The author has formerly announced that cyanacetic ether is able to exchange its hydrogen for sodium. To obtain this compound it is sufficient to treat a solution of the ether in absolute alcohol with the theoretical quantity of sodium alcoholate. The compound is white, almost insoluble in absolute alcohol, but soluble with decomposition in water. If exposed to the air it absorbs moisture and carbonic acid.

On the Ethyl Cyanoacetate of W. James.—Alb. Haller and Alfred Held.— The authors show that this compound, described in the *Journal of the Chemical Society* for April last (p. 287), is identical with the ethyl aceto-cyanacetate which they prepared five years ago (see *Comptes Rendus*, xcv., p. 235).

Determination of Starch in the Tubers of the Potato.—Aimé Girard.—The author places a known weight of rasped potatoes in contact, firstly with a weak solution of hydrochloric acid, to render the cellulose of the vegetable tissue easily attackable, then with a sufficiency of ammonio-cupric liquid to dissolve this cellulose, and to swell the starch. He then supersaturates with acetic acid and treats the mixture first with a normal and then with a decinormal solution of iodine in potassium iodide.

Organic Nitrogen in Compound Chemical Manures. — M. Gassaud. — The presence of leather waste in manures can be detected by means of the reactions of tannin. The author exhausted the sample with boiling water; he then made a similar decoction of leather and compared them with an aqueous solution of tannin. All three gave blue-black precipitates with ferric chloride, brown precipitates with potassium dichromate, and red precipitates with magenta. With ferrous acetate the decoctions of the manure gave a deep violet blue precipitate, and the solution of tannin a blue-black. Horn, blood, flesh, &c., gave nothing similar.

Journal de Pharmacie et de Chimie.
Series v., Vol. xv., No 8, April 15, 1887.

Action of the Fluorides upon Alumina.—MM. Fremy and Verneuil.—Alumina, without being in actual contact with calcium fluoride, but merely exposed to the emanations given off by this body, if ignited in the air, becomes mineralised, loses its amorphous condition, and is changed into a crystalline mass.

Characters of Debilitation undergone by Diastase under the Action of Heat.—E. Bourquelot.—Enfeebled diastase, even if used in excess, loses the power of pushing the degradation of starch to its utmost limit.

The Organisms producing the Decomposition of Urine.—M. Smith.—From the *British Medical Journal.*

Preservation of Yeast. — M. Boehm. — From the *Moniteur Scientifique.*

Detection of Traces of Chlorine.—M. Hager.—The reagent recommended is a solution of diphenylamine in strong sulphuric acid, which is poured gently down the side of the vessel containing the liquid under examination. If no blue colour appears, even after the lapse of some minutes, a fresh quantity of pure sulphuric acid is added. The presence of the least trace of chlorine is shown by a blue zone at the contact of the two liquids.

Bullelin de l'Association des Elèves de M. Fremy.
No. 8.

Preparation of Calcium Sulphide having a Violet Fluorescence.—A. Verneuil.—Already noticed.

New Process for the Chlorination of Carbides.—A. Colson.— A carbide is heated with a known weight of phosphorus pentachloride in a sealed tube to about 180°. The phosphorus chloride liberates a definite quantity of chlorine, which reacts upon the hydrocarbonic molecule.

Method for the Volumetric Determination of Sulphates. — H. Quantin. — Already noticed under the *Comptes Rendus.*

Practical Analysis of Coal-Gas as regards Ammonia, Hydrogen Sulphide, Carbon Dioxide, and Monoxide.— M. Chevalet.— The author describes here his process for the determination of ammonia.

New Processes for Preparing Crystalline Carbonates.—L. Bourgeois.—Already noticed.

MISCELLANEOUS.

International Review on the Adulteration of Food and Drink.—A new periodical is about to be published at Amsterdam under the above title. It will appear six times per annum, the first number on 15th July. The subject is an important one, and owing to its international character the new journal will doubtless be of service to the public health.

Lower Oxides of Molybdenum.—W. Muthmann.—The author has examined molybdenum dioxide, molybdenum dioxide molybdate, the action of reductive gases upon molybdic acid, and the intermediate oxides of molybdenum soluble in water. These include the blue oxide, Mo_3O_8, a definite compound and the olive-green oxide, which, if a definite body at all, seems too instable to admit of analysis. There is here, further, an account of the action of concentrated sulphuric acid upon metallic molybdenum, and of the combinations of molybdenum dioxide with bases. *Liebig's Annalen.*

Royal Dublin Society.—An adjourned general meeting of the Royal Dublin Society was held on Thursday, June 30th, for the purpose of confirming the new by-laws, and alterations in the old ones, rendered necessary by the resolution passed on March 3rd, to the effect that it is desirable that ladies be admitted as members of the Society. The great advances which have been made of late years in the higher education of women show that the fair sex are capable of doing excellent scientific work, and in such cases it is only just that they should be received as members of the societies to which they contribute the results of their researches. At the same time it will be as well not to be too ready in admitting all candidates, or there will be danger of converting what should be a scientific meeting into merely a social gathering.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Aluminate of Soda.—A correspondent ("W. C. L.") in your issue of July 1st asks for the address of a maker of aluminate of soda. Will you kindly give him ours?—SULLIVAN AND Co., LIM., British Alkali Works, Widnes, Lancashire.

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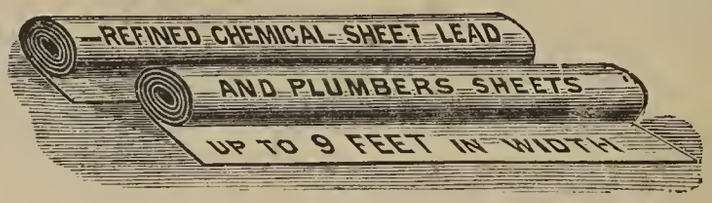

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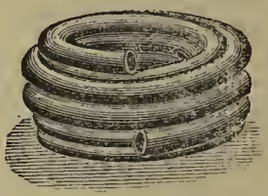

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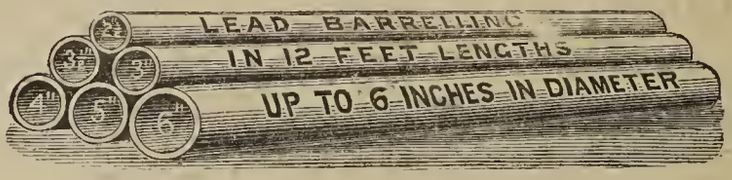

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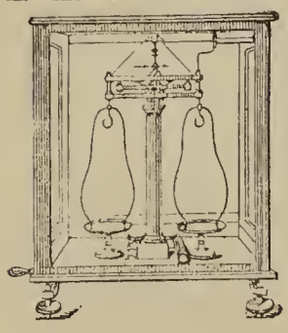

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July 8, 1887.

THE CHEMICAL NEWS.

Vol. LVI. No. 1442.

ON A NEW METHOD OF MEASURING MAGNETIC SUSCEPTIBILITY AND MAGNETIC PERMEABILITY.

By THOMAS T. P. BRUCE WARREN.

The following method of measuring magnetic forces opens up an important branch of chemical physics, and makes magnetism itself an interesting adjunct to analytical research.

Ordinary German silver, when tested with a magnet in the ordinary way, shows no attraction whatever, but if examined in this way is decidedly attracted by a magnet. It was, in fact, from examining the contacts of electrical apparatus, to determine what metal or alloy was used, that this method of procedure was developed.

A delicate chemical balance is placed on a firm table, and in the magnetic meridian. A weight of the substance whose susceptibility is required, either in powder or fine filings, is placed evenly on the pan of the balance, and equilibrium carefully made; a powerful horse-shoe magnet is then placed directly under the pan, which is prevented from approaching within a certain distance of the magnet. Care must be taken that, in every case, it should occupy the same position. Of course it would be more convenient to employ an electro-magnet, which could be fixed, and, after adjusting the weights, the magnet could be excited by contact with a battery. When a very intense magnetic field is required, a coil of wire connected with a dynamo is placed under the scale pan.

If we are operating on a paramagnetic or positive substance, the pan will be drawn down by the action of the magnet, and weights will have to be added to restore equilibrium. The weights required to restore equilibrium is a measure of the susceptibility of the substance in hand.

If, however, we are working with a diamagnetic or negative substance, we should expect the pan to be repelled. As these so-called substances are also attracted, we are driven to the conclusion that diamagnetism as opposed to paramagnetism, in its general acceptation, has no existence; still, although a substance may have its poles, relatively to an exciting magnet, as implied by these prefixes, no case of magnetic repulsion has yet been met with.

A carefully balanced platinum crucible was found to be strongly attracted. Bismuth was decidedly attracted, but behaved with a curious sluggishness, which was very much reduced by diminishing the distance. Metallic manganese, although not affected by a magnet in the ordinary way, has a decided influence by this method of testing.

It is preferable in some cases to attach a powerful magnet to one of the ends of the beam, in place of the scale pan, as we are then independent of the magnetic influence due to the metal of the pan, and, having once balanced the magnet, we obviate the necessity of having to weigh each substance operated on.

We are indebted to Sir William Thomson for the terms magnetic "susceptibility" and magnetic "permeability," and it is in precisely the same sense as used by him that those terms are employed in this paper; thus "susceptibility" implies that condition which ordinarily is understood of becoming magnetic, and "permeability" may be taken as meaning the power of conversely arresting the transmission of magnetic energy, or a kind of porosity.

In addition to these terms we frequently use the expressions "retentive power" and "residual magnetism." These terms express what is practically the extremes of the same idea. Many substances are magnets when under the influence of another magnet, but as independent magnets return almost to their zero condition. The power of retaining magnetic polarity, *per se*, deserves a scientific recognition. It has now become a recognised fact that the retentive power of steel can be increased by the addition of other metals; although, themselves feebly magnetic, it is generally considered that their influence is due to tempering or hardening iron.

Residual magnetism may be roughly measured by noting first the force which draws the magnet to the substance experimented on, and, after magnetising by any of the ordinary methods, replace the same, and note the alteration in the attractive force. The same method may be used for measuring the rate of acquiring, under a constant magnetic force, the maximum of induced or permanent magnetism.

In experimenting on the magnetic permeability of substances the arrangement of the magnet or magnetic field is the same as in the previous case: a plate of the metal or stratum of liquid is inserted between the magnet and some iron filings or magnet.

When the plate is removed the magnet is attracted to within a fixed distance of the filings, the weight required to produce equilibrium is noted; the plate is then inserted, and the diminished attraction again noted. The difference in weight is due to the arrest of magnetic influence by the interposed layer.

The effect produced by differences in thickness of the interposed layer does not appear to follow the law of variation for magnetic attraction as generally accepted.

The magnetic permeability is known to be a function of susceptibility. A class of substances appear to exist which are almost magnetic insulators, but as a rule the higher the susceptibility of a substance is, the greater will be its permeability: this we might have expected.

This method of experimenting on magnetic permeability leads to the conclusion that we are not warranted in treating a vacuum as magnetic; on the contrary we have, simply by exhaustion, altered the permeability of an interposed layer of air. When a magnetic substance is made to approach a balanced magnet, the force of attraction was as follows:—

At 41·0 m.m.	distance	0·026	grm.
,, 20·5 ,,	,,	0·520	,,
,, 14·0 ,,	,,	1·300	,,

so that at one-third the distance, in this experiment, the attraction is fifty times as great.

The magnetic force is no doubt increased, partly by the diminished distance, and partly by increasing the permeability of the intervening layer of air in consequence of reducing the thickness of the stratum.

In order to obtain comparative results the unit weight is less reliable than the unit volume. It seems to me that the unit adopted must, in the case of a substance of definite chemical nature, be a function of its molecular weight.

I am working on this matter with a view of ascertaining the magnetic equivalents of substances,—that is, the weights of substances required to produce the unit force, at the unit distance, in the unit field.

A curious result of this enquiry is, that in delicate chemical operations where weighing magnetic substances is concerned, we cannot disregard the intensity and horizontal force in the place where our weighings are made.

Action of Crystalline Acetic Acid upon Lævo-Rotatory Camphene.—J. Lafont.—The action of acetic acid upon lævo-rotatory camphene only gives rise to a single acetate, which is dextro-rotatory, and which, on saponification with alcoholic potassa, yields merely camphenol and acetic acid.—*Comptes Rendus*, Vol. civ., No. 24.

STUDY ON THE REACTIONS OF THE VANADATES FROM AN ANALYTICAL POINT OF VIEW.

By A. CARNOT.

The author has previously shown that vanadic acid forms with barium a salt insoluble in water containing ammonium chloride and very little free ammonia, and that under the same conditions the salts of strontium give no precipitate, a characteristic which may be utilised either for the determination of vanadic acid or for the separation of barium and strontium.

Lime and Magnesia.—The salts of lime and those of magnesia behave like those of strontium, and yield no precipitate in dilute solutions. The case is different with the phosphoric and arsenic acids. In strong and highly ammoniacal solutions there is formed a partial deposit of vanadate, which renders the separation of these acids by means of magnesium salts inaccurate.

Alumina.—On neutralising an acid solution containing vanadic acid and alumina, the latter in precipitation carries down with it vanadic acid. They cannot be completely separated even on repeating the operation many times. Nor can we succeed by precipitating the alumina in a slightly acetic solution, nor by employing ammonium hydrosulphate. The presence of traces of vanadium is always shown by the brownish colouration which the alumina takes on contact with ammonium hydrosulphate.

Chromium.—Chromium sesquioxide likewise fixes the vanadic acid, and may even retain it entirely, if in sufficient quantity, on precipitation either with ammonia or with ammonium hydrosulphate.

Uranium : Determination as Vanadate.—Uranium salts precipitate vanadic acid entirely, not merely when the liquid is ammoniacal, but also in presence of a slight proportion of free acetic acid, as occurs on precipitating the phosphoric and arsenic acids. This reaction may be utilised for the determination of vanadic acid.

We neutralise the acid solution almost completely with ammonia ; we add a few grammes of ammonium acetate, and a sufficiency of uranium nitrate, and raise to a boil. Then is formed a yellow precipitate resembling arsenic sulphide in colour.

We ascertain that the reagent is in excess by taking up a drop of the liquid with a glass rod and letting it fall upon a plate in contact with a drop of potassium ferrocyanide. This drop ought to be tinged brown by the uranium salt, if any of it remains in solution. The precipitate is received upon a filter, washed with pure water, dried, and separated from the filter, which is burnt separately. The precipitate, on ignition to redness, loses water and ammonia, taking a pale yellow colour. It contains then 24·22 of vanadic acid. This determination succeeds not only in presence of the alkalies and alkaline earths, but also with most of the metallic oxides. It is especially suitable for isolating vanadic acid from the oxides of manganese, zinc, and copper, which accompany it in certain natural vanadiates.

But the uranium salt cannot serve for separating vanadic acid from phosphoric and arsenic acids, often found in the same ores, because they are entirely precipitated,—nor from molybdic and tungstic acids, which are at least partially precipitated by the same reagent.

Iron.—Vanadic acid is partially carried down in the precipitation of ferric oxide, but it is not as difficult to separate from this base as from alumina or chrome. We can succeed by means of ammonia or ammonium acetate or hydrosulphate, repeating the operation several times.

Manganese : Determination as Vanadate.—Manganese oxide forms with vanadic acid a definite and insoluble compound, which mny be usefully employed in the determination of vanadium.

The vanadic solution is mixed with ammonium chloride and ammonia in slight excess, and heated to a boil. There is then poured in manganese sulphate or chloride mixed with sal-ammoniac, and the whole is boiled for two or three minutes. The flask is removed from the fire (giving off a slightly ammoniacal odour) ; it is plunged into cold water, and allowed to stand until clear. It is then filtered, and washed with cold water. The precipitate is a yellowish brown divanadate. It should not contain brown particles. On ignition it passes to a reddish brown, and contains 56·25 per cent of vanadic acid.

Vanadic acid cannot be separated in this manner from phosphoric or arsenic acid, as they are both entirely precipitated under the same conditions. They might, in certain cases, be determined by the same method.

Tungstic acid is also, in part, precipitated on boiling with a salt of manganese.

Molybdic acid, on the contrary, remains entirely in the ammoniacal solution, especially if the ebullition is not kept up too long. It may then be determined by precipitating the manganese by ammonium hydrosulphate, and, lastly, molybdenum sulphide by hydrochloric acid. The separation of vanadium and molybdenum is thus effected with great exactness.

The precipitation of vanadic acid by a salt of manganese is a convenient means for its extraction from alkaline or ammoniacal solutions. It must be precipitated either in heat or in the cold as manganese vanadate ; then ignited with sulphur or in a slow current of hydrogen sulphide, and finally treated with hydrochloric acid diluted with 15 or 20 vols. of water. The manganese sulphide is easily dissolved, while the vanadium sulphide remains untouched.—*Comptes Rendus*, Vol. civ., p. 1844.

CONTRIBUTIONS TO OUR KNOWLEDGE OF ANTIMONY PERCHLORIDE.*

By RICHARD ANSCHÜTZ and P. NORMAN EVANS.

(Concluded from p. 2).

The Reaction of Antimony Pentachloride and Oxalic Acid.

As has already† been remarked, our research on the chlorides of antimony sprung originally from the wish to find out if the reaction of anhydrous oxalic acid and antimony pentachloride was analogous to that of phosphorus pentachloride, forming an antimony oxychloride, $SbOCl_3$, corresponding to the oxychloride of phosphorus. The knowledge of the action of water on antimony pentachloride, forming mono- and tetra-hydrates, increased the interest in the attempt to discover the action of oxalic acid on the same body.

On mixing equal molecular weights of pure anhydrous oxalic acid and antimony pentachloride, a violet development of hydrochloric acid takes place, the mixture forming a nearly solid white mass. The generation of hydrochloric acid soon ceases. On heating to about 150° decomposition begins again, carbonic dioxide and hydrochloric acid being given off, the mass becoming gradually liquid. This clearly showed that the reaction ran in two stages. In the case of the monohydrate we had obtained our object so quickly by the use of chloroform, that we did not pursue the direct action of antimony pentachloride on oxalic acid further, but substituted a cooled solution of 35·5 grms. of antimony pentachloride in 83·3 grms. of chloroform, with 10·6 grms. of anhydrous oxalic acid. The reaction commenced in the cold ; at first hydrochloric acid mixed with a small quantity of carbon dioxide was given off, but soon only hydrochloric acid ; gradually a considerable amount of a white crystalline body fell out of solution. After the development of hydrochloric acid had ceased, we heated the product of the reaction, dissolving the greater part of the crystals. We filtered hot, and

* A Paper read before the Royal Society, June 16, 1887.

† *Chem. Soc. Journ.*, vol. xlix., p. 708.

beautiful transparent colourless crystals separated from the filtrate, which we had placed in a desiccator over sulphuric acid and paraffin. The residue, insoluble in the hot chloroform solution, weighed 4·9 grms., and consisted chiefly of unaltered oxalic acid. The quantity of hydrochloric acid collected was 4·7 grms., while 8·5 grms. should have been found had the reaction taken place according to the equation—

$$(COOH)_2 + SbCl_5 = SbCl_3O + CO_2 + CO + 2HCl.$$

This reaction was, however, impossible, owing to the small quantity of carbon dioxide given off. The quantity of hydrochloric acid found indicated that two molecules of antimony pentachloride had reacted with one of oxalic acid. The tabular crystals from the chloroform solution melted at from 148·5° to 149°, decomposing at a somewhat higher temperature. The values found by analysis corresponded to the formula $Sb_2Cl_8C_2O_4$.

	Grm. substance.		
1.	0·4680	gave 0·2637	Sb_2S_3.
2.	0·2647	,, 0·1421	Sb_2S_3.
3.	0·1444	,, 0·2670	AgCl.
4.	0·2261	,, 0·4174	AgCl.
5.	0·8117	,, 0·1950	$C_2O_4Ca + H_2O$.
6.	0·2522	,, 0·0589	$C_2O_4Ca + H_2O$.
7.	0·2956	,, 0·0415 CO_2 and 0·0160	H_2O (Combustion with lead chromate.)
8.	0·8777	,, 0·1162 CO_2 and 0·0162	H_2O (Combustion with lead chromate.)

As a result of these simple experiments we can understand the entirely different behaviour of antimony and phosphorus pentachlorides towards the carbon compounds containing oxygen and hydrogen. Antimony pentachloride unites, as we have proved, with water. Phosphorus pentachloride decomposes water. Antimony pentachloride has no inclination to change chlorine for oxygen. Phosphorus has this inclination in an extraordinary degree. Phosphorus pentachloride attacks hydroxyl or ketone groups, replacing oxygen by respectively one or two atoms of chlorine, being itself converted into oxychloride. Antimony pentachloride, on the other hand, reacts on the hydrocarbon residue, substituting chlorine for hydrogen, and itself becoming antimony trichloride.

Phosphorus pentachloride acts similarly to antimony pentachloride, substituting chlorine for hydrogen in those organic compounds which contain no oxygen, or oxygen in such firm combination with carbon as not to be available for the formation of phosphorus oxychloride.

Antimony pentachloride may react as phosphorus pentachloride on compounds similar to oxalic acid, containing no hydrogen attached to carbon which can be replaced by chlorine. The compound $(COOSbCl_4)_2$ is of especial theoretical interest, as showing the process of the reaction of phosphorus pentachloride on substances containing the hydroxyl group. The first stage of the reaction consists, evidently, of the formation of compounds analogous in composition to the body $(COOSbCl_4)_2$.

If, however, the oxygen of a hydroxyl group is held in loose combination, the formation of phosphorus oxychloride and the substitution of chlorine take place simultaneously. What, however, will happen when the substitution of oxygen is difficult, as in phenol or the aromatic oxyacids? Attempts to answer this question are now in progress in the laboratory of the Chemical Institute of the University of Bonn, and we anticipate that the result will be the preparation of bodies having the general formula $R'OPCl_4$.

	Calculated for $Sb_2Cl_8C_2O_4$.	Found. 1.	2.	3.	4.	5.	6.	7.	8.
Sb	39·61	38·93	38·52	—	—	—	—	—	—
Cl	46·10	—	—	45·74	45·64	—	—	—	—
C	3·89	—	—	—	—	—	—	3·83	3·61
C_2O_4	14·28	—	—	—	—	14·47	14·07	—	—
H	—	—	—	—	—	—	—	0·59	0·20

The compound, $Sb_2Cl_8C_2O_4$, is formed according to the equation—

$$(COOH)_2 + 2SbCl_5 = C_2O_4Sb_2Cl_8 + 2HCl.$$

Proceeding exactly as described above, but taking one molecule of oxalic acid to two of antimony pentachloride, *i.e.*, twice the quantity, almost the entire product is soluble in chloroform.

37·2 grms. $SbCl_5$ dissolved in 55 grms. $CHCl_3$ and
5·5 grms. $(COOH)_2$ gave
4·3 grms. of HCl, the calculated quantity being
4·8 grms.

It is necessary to have a good return-flow condenser in order to avoid a considerable quantity of chloroform distilling into the weighed water, used for collecting the hydrochloric acid. On mixing $Sb_2Cl_8C_2O_4$ with warm water, it is decomposed, setting oxalic acid free. This may be easily determined after removing the antimony from the acid solution. The following constitutional formula seems most simply to explain the formation and decomposition of this new compound:—

$$\text{I.} \quad \begin{matrix} COOSbCl_4 \\ | \\ COOSbCl_4 \end{matrix},$$

oxalic acid in which the hydrogen atoms are replaced by the univalent radical $Sb'Cl_4$. Considering the fact that the compound does not unite with a second molecule of oxalic acid, the formula—

$$\text{II.} \quad \begin{matrix} COO \\ | \\ COO \end{matrix}\!\!>\!SbCl_3SbCl_5$$

does not seem at all probable. According to formula I. one can compare the compound with diammonium oxalate, and designate it as ditetrachlorstibonium oxalate, or, as we prefer, look on it as the mixed anhydride of oxalic acid and the yet unknown acid, $SbCl_4OH$.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, June 16th, 1887.

Mr. WILLIAM CROOKES, F.R.S., President, in the Chair

MR. WILLIAM HENRY COATES was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. George Carrington, B.A., Missenden Abbey, Great Missenden, Bucks; Yoshimosa Koga, Imperial Mint, Osaka, Japan; William Henry Richardson, Dudley; Arthur Walley Warrington, Dinglefield, Dingle Lane, Liverpool.

The following were elected Fellows of the Society:—Messrs Hugh Barclay, William Bott, L. C. Daniell, Ernest Francis Ehrhardt, William Nathaniel Evans, Frederick William Freeman, Edward Day Gravill, Herbert James Gover, John Edward Green, Richard Nelson Jones, M.R.C.S., Khasberas B. Jodhara, J. M. Kavanagh, William Marshall, Henry Hewetson McMinnes, Fred. Lawrence Overend, B.A., J. Stanley Phillips, John T.

Sheard, Walter Shelley Spencer, Charles Ernest Stedman, Henry Livingstone Sulman, Frank Traphagen, Ph.D., Frederick Percy Watson, John William Young, B.A.

The President announced that the following Address had been presented to Her Majesty :—

TO THE QUEEN'S MOST EXCELLENT MAJESTY.

MAY IT PLEASE YOUR MAJESTY,

On the happy completion of the fiftieth year of your Most Gracious Majesty's reign we, the President, Council, and Fellows of the Chemical Society, established in 1841 and incorporated under a Charter granted in the 12th year of your Majesty's reign, desire to present to your Majesty our sincere congratulations, and to express our loyal devotion to your August Person and to your Throne.

We humbly submit, amidst the general rejoicing, that we have special reason to rejoice in the growth of Science, and particularly of Chemical Science, which characterises your Majesty's wise and beneficent reign. It it be borne in mind to what an extent the applications of Chemistry are now essential to the prosperity and the security of your Majesty's Empire, this development assumes a truly national importance.

Chemistry is of no nationality, yet the names of Black, Cavendish, Dalton, Davy, Faraday, and Graham fully testify to the vigour of its growth on British soil. From a variety of causes, however, its cultivation in this country during the second quarter of the century seemed to be falling into neglect, and it is to His Royal Highness the late Prince Consort that the nation is very largely indebted for its revival.

The turning-point in the history of Chemical Science in your Majesty's Dominions was the foundation of the Royal College of Chemistry in the year 1845. To the success of this College the Prince Consort contributed, not merely by his personal munificence and by consenting to become its first President, but more particularly by using his influence to overcome the obstacles in the way of the appointment of its first Professor.

The result cannot be exaggerated; indeed, a majority of British Chemists of the younger generation are directly or indirectly the pupils of that College, while the discoveries in Chemical Science of its Students may well rank amongst the most brilliant achievements of your Majesty's reign.

If Chemical Science in this country is no longer ignored, but is recognised as essential to national prosperity, if Chemistry has won its rightful place in the curriculum of the higher education, and if laboratories properly organised for the conduct of this intellectual discipline are to be found in British Universities, Colleges, and Schools, these happy changes are mainly due to the exertions and influence of the late Prince Consort and to the impulse given by the Royal College of Chemistry in response to his encouragement. The Prince Consort's enlightened zeal in the furtherance and development of Science in the country of his adoption is universally recognised, and we rejoice to find that his Royal Highness the Prince of Wales treads in the footsteps of his illustrious father.

It is our most earnest prayer that your Most Gracious Majesty may long be spared to reign over a happy, loyal, prosperous, and united empire, and that your Majesty's enlightened and beneficent example may steadily be followed and held in grateful remembrance.

We remain, with profund respect,

YOUR MAJESTY'S MOST FAITHFUL SERVANTS.

The following papers were read :—

59. "*A Study of the Thermal Properties of the Mixture of Ethyl Alcohol and Ethyl Oxide.* By WILLIAM RAMSAY, Ph.D., and SYDNEY YOUNG, D.Sc.

The authors have previously shown that for both the gaseous and the liquid states, the relation of pressures to temperatures at constant volume may in the case of methyl and ethyl alcohols, ethyl oxide and carbon dioxide, and presumably in the case of all stable liquids, be expressed by the formula $p = bt - a$; *i.e.*, the isochoric lines, or lines of equal volume, for unit mass of the substance. are straight when mapped against pressures as ordinates and temperatures as abscissæ. They also showed that in the case of the two dissociating substances, acetic acid and nitric peroxide, such isochoric lines are not straight, but are, at large volumes, tangential to the theoretical isochoric lines of minimum density at higher temperatures, and at lower temperatures probably tangential to the theoretical isochoric lines of maximum density. A comparison of the behaviour of such stable and dissociable substances has shown the effect of chemical union on the relations of pressure, temperature, and volume. But the mixture of two liquids, such as alcohol and water, is known frequently to be accompanied by contraction and by evolution of heat. It therefore appeared of interest to thoroughly investigate the behaviour of such a mixture in order to throw light on the nature of this attraction.

Experiments were therefore made with a view to determining the relations of volume, pressure, and temperature between wide limits with a mixture of alcohol and ether, of which, individually, the constants have already been obtained.

The most striking conclusions are (1) the dependence of pressure during condensation on volume, so that the vapour-pressures are represented not by a line but by a band; (2) the curvature of the isochoric lines at temperatures and pressures near the condensing points of the mixture; (3) the great alteration of volume under certain conditions on mixing the two bodies, amounting, on the one hand, in some circumstances to a contraction of 4 per cent, and in others to an expansion of 115 per cent.

DISCUSSION.

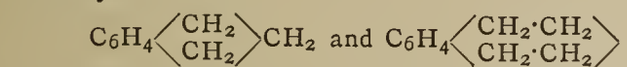
Prof. DEWAR said that, in dealing with the historical part of the subject, the authors of the paper had in his opinion omitted to do full justice to the work of Amagat and other investigators. A short time ago Messrs. Ramsay and Young had communicated a paper to the Royal Society, entitled "A Preliminary Note on the Continuity of the Liquid and Gaseous States of Matter," which had been referred to that evening, purporting to contain a discovery which was nothing more than a simple elementary deduction from Van der Waals' formulæ representing the continuity of the gaseous and liquid states of matter. The Van der Waals' formula had been improved upon by Clausius; in its original form, however, it was still sufficient to account for Andrew's isothermal law and Amagat's law of the limiting volume of a gas under high pressure,—two of the most important experimental deductions from a vast number of observations. Prof. Amagat in continuing his work had discarded all antecedent theoretical views, and had confined his attention to the approximate laws he could deduce from the experimental facts. He had long ago given the equation that Messrs. Ramsay and Young evidently thought important enough to embody in the form of a paper. In dealing with this subject the mass of calculations made by the authors may satisfy some views, but real progress in this department of physico-chemical inquiry can only be made by reaching greater accuracy in the measurements, always assuming that the substances examined are pure. Endless repetitions of details can only cumber the ground, not clear it.

The experiments on the critical volume of PH_4Cl, to which Dr. Young referred, were in reality made by a pupil of the speaker (Mr. Skinner), and had already been published.

Dr. YOUNG, in reply, said that the work of Amagat and others was referred to in the paper, but owing to the short time at his disposal he had been unable to do full justice to the history of the subject that evening. Although Van der Waals' formula could be converted into theirs, the converse was not the case; moreover, Van der Waals' formula did not represent the facts.

60. "*Derivatives of Hydrindonaphthene and Tetrahydronaphthalene.*" By W. H. PERKIN, Jun., Ph.D.

The author describes experiments which have enabled him to prepare from *ortho*xylene derivatives of the closed chain hydrocarbons—



Hydrindonaphthene. Tetrahydronaphthalene.

Hydrindonaphthenedicarboxylic acid was obtained from the ethylic salt formed by the action of the dibromide, $C_6H_4(CH_2Br)_2$—prepared by heating orthoxylene with bromine at 125°—on the disodium-derivative of ethylic malonate, $CNa_2(COOEt)_2$: when heated at 200° this acid is resolved into carbon dioxide and hydrindonaphthenecarboxylic acid.

Tetrahydronaphthalene-derivatives were obtained in two ways: (1) by the action of orthoxylylene dibromide on the disodium-derivative of ethylic acetylenetetracarboxylate,—

$$\begin{matrix} CNa(COOEt)_2 \\ \dot{C}Na(COOEt)_2 \end{matrix};$$

and (2) as the end result of the following series of changes:—Ethylic sodiomonochloromalonate,—

$$CNaCl(COOEt)_2,$$

having been submitted to the action of orthoxylylene dibromide; the resulting compound,—

$$C_6H_4[CH_2{\cdot}CCl(COOEt)_2],$$

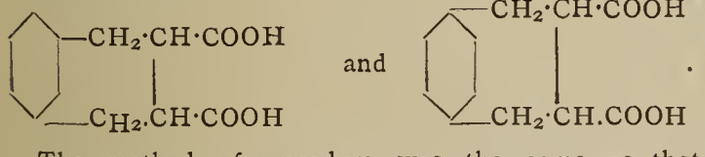
was digested with zinc-dust and acetic acid, and the chlorine having been displaced by hydrogen, the product was converted into the disodium-derivative,—

$$C_6H_4\begin{cases} CH_2{\cdot}CNa{\cdot}(COOEt)_2 \\ CH_2{\cdot}CNa{\cdot}(COOEt)_2' \end{cases}$$

which on treatment with iodine gave the theoretical amount of tetrahydronaphthalenetetracarboxylate. On heating the tetracarboxylic acid at 200° it is resolved into CO_2, water, and the anhydride of tetrahydronaphthalenedicarboxylic acid; on dry distillation of the silver salt of this latter acid, naphthalene is produced, together with the anhydride of tetrahydronaphthalenedicarboxylic acid, silver, CO_2, and water.

61. "*The Synthetical Formation of Closed Carbon Chains in the Aromatic Series.*" By F. S. KIPPING, B.Sc., Ph.D.

The author describes experiments which were instituted with the object of ascertaining whether it would be possible, by substituting meta- and para-xylene for orthoxylene, to obtain isomeric tetrahydronaphthalene derivaof the formulæ—



The method of procedure was the same as that described in the previous paper. Meta- and para-xylylene dibromides were each treated with ethylic sodiochloromalonate, the product was reduced with zinc-dust and acetic acid, and the reduction product was converted into the sodium-derivative, which was treated with bromine.

The reaction appeared to take place with perfect regularity, sodium bromide separating; but on examination it was found that the greater part of the product consisted of the unchanged substance, and no new closed chain compound could be detected. It is difficult to understand what really takes place in these reactions, or what the precise action of the bromine on the sodium compound is.

DISCUSSION.

Dr. MILLER thought that since the authors had not yet proved even the possible existence of rings consisting of 7 and 8 carbon atoms, the experiments quoted by them could not be considered as proof that ring-formation from two side-chains attached to a benzene nucleus depends solely on *position*. The chain of 6 carbon atoms in the ortho-compound,

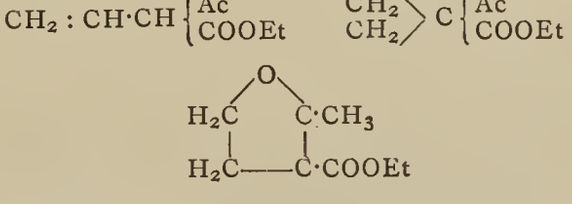
$$C_6H_4\begin{matrix} CH_2.CNa(COOEt)_2 \\ CH_2{\cdot}CNa(COOEt)_2' \end{matrix}$$

might be expected to yield a ring composed of 6 carbon atoms, because such rings are not only possible but possess very great stability. There is, however, nothing surprising in the fact that the chains of 7 and 8 carbon atoms in the corresponding meta- and para-compounds do not yield corresponding rings, especially when considered in conjunction with Dr. Perkin's other unsuccessful attempt to produce a ring containing 7 atoms of carbon. The well-known property possessed by so many ortho-derivatives of readily yielding anhydro- and other ring-derivatives is without doubt a function of the 1 : 2 position, but whether this is so in the case of the above-mentioned compound cannot be regarded as proved. Indeed it is conceivable that the length of the side-chains may be an important factor in determining the condensation. It would be interesting to ascertain whether an *ortho*-derivative of similar constitution to the above, but containing an additional atom of carbon in each side-chain, would also yield a ring-derivative; if not, it would be an argument that ring formation depends on *length* of chain as well as position.

Dr. KIPPING said, in reply, that he had anticipated the objection raised to the theoretical conclusions he had deduced from his experiments. He had, therefore, tried a number of experiments on the action of metaxylylene bromide on the sodium-derivative of ethylic malonate. If a reaction analogous to that which resulted in the formation of hydrindonaphthene-derivatives from orthoxylylene bromide were to take place, a compound should have been formed containing a ring consisting of *six* carbon atoms, in which, however, the junction was effected to carbon atoms in the meta-position. In no case, however, could such a substance be obtained. It therefore appeared to him that the main reason why ring-formation did not take place, when meta- and para-derivatives of benzene were used, was that the side-chains were not in a suitable position.

62. "*The Product of the Action of Ethylene Bromide on Ethylic Acetosodacetate.*" By P. C. FREER, Ph.D., and W. H. PERKIN, Jun., Ph.D.

The compound formerly described by W. H. Perkin, Jun., as ethylic acetyltetramethylenecarboxylate having been proved to contain a carbon-oxygen-ring, being an anhydride of a carboxylate of acetobutylic alcohol, it was thought advisable to examine the product of the action of ethylene bromide on ethylic acetosodacetate, in order to finally settle the nature of the compound known as ethylic acetyltrimethylene carboxylate. Ethylene bromide interacts with ethylic acetosodacetate, forming a compound, $C_8H_{12}O_3$, to which the following formulæ are applicable:—



That the first is inapplicable has been shown in a previous publication: further experiments show that the product is to be regarded as a mixture of the compounds represented by the latter two formulæ. That this is the case is proved by the decomposition of the acid obtained from the ethereal salt; if this be distilled CO_2 is given off, and an oil passes over, separable into two substances, one boiling at 112°, which is insoluble in water, even after standing for weeks; the other boiling 20° lower, which gradually dissolves in water, forming acetopropylic alcohol. It is therefore safe to regard the ethereal salt,

$C_8H_{12}O_3$, as a mixture of ethylic acetyltrimethylene-carboxylate with a compound which it is proposed to call ethylic *methyldehydropentonecarboxylate*.

The acids obtained on hydrolysing the ethereal salt just referred to are decomposed on boiling with water into CO_2 and acetopropylic alcohol. This reaction is in entire accordance with the character of the trimethylene-ring, as shown in the change of trimethylenedicarboxylate into carbobutyrolactone.

The ether $C_8H_{12}O_3$ readily combines with hydrogen bromide, forming ethylic ω-bromethyl acetoacetate, a change which is likewise in accordance with the behaviour of the other trimethylene compounds.

If this latter compound be boiled for some hours with dilute muriatic acid, it is quantitatively converted into alcohol, CO_2, HBr, and acetopropylic alcohol. Acetopropylic alcohol is easily reduced by sodium amalgam, being converted into γ-pentylene glycol.

63. "*Derivatives of Pentamethylene.*" By H. G. Colman, B.Sc., and W. H. Perkin, Jun., Ph.D.

γ-Pentylene glycol, $CH_3{\cdot}CH{\cdot}(OH){\cdot}CH_2{\cdot}CH_2{\cdot}CH_2(OH)$, is converted by the action of HBr into the corresponding γ-pentylene dibromide, $CH_3{\cdot}CHBr{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2Br$.

When this bromide is mixed with ethylic sodiomalonate in alcoholic solution the following reaction takes place:—

$$2CHNa(CO_2Et)_2 + CH_3{\cdot}CHBr{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2Br = CH_2\begin{<}CH_2{\cdot}CH{\cdot}CH_3 \\ CH_2{\cdot}C(CO_2Et)_2\end{>} + CH_2\begin{<}CO_2Et \\ CO_2Et\end{>} + 2NaBr.$$

Ethylic methylpentamethylenedicarboxylate is a pleasant smelling oil, b.-p. 243° to 244°. The corresponding acid is crystalline, and melts at 173° to 175°, decomposing into CO_2, and methylpentamethylenemonocarboxylic acid. The latter is a colourless liquid which boils at 220°; it possesses a penetrating smell similar to that of butyric acid.

64. "*The Synthesis of Hexamethylene-derivatives.*" By P. C. Freer, Ph.D., and W. H. Perkin, Jun., Ph.D.

Hitherto all attempts to synthesise hexamethylene-derivatives have been unsuccessful, owing to the impossibility of obtaining a pentamethylene dibromide of the formula $CH_2Br{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CHBr$, which could be submitted to the action of ethylic sodiomalonate. The authors have, however, succeeded in preparing a homologue of the desired bromide from acetobutylic alcohol, $Ac{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2OH$. This alcohol is readily reduced to δ-hexylene glycol by means of sodium amalgam, as Lipp has shown. This glycol is completely converted by treatment with hydrogen bromide into δ-hexylene dibromide, $CH_3{\cdot}CHBr{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2Br$, which interacts with ethylic sodiomalonate, forming ethylic methylhexamethylenedicarboxylate,—

$$CH_3{\cdot}CH{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2.CH_2{\cdot}C(COOEt)_2.$$

65. "*An Attempt to Synthesise Heptamethylene-derivatives.*" By P. C. Freer, Ph.D., and W. H. Perkin, Jun., Ph.D.

If δ-hexylene dibromide, $CH_3{\cdot}CHBr{\cdot}(CH_2)_3{\cdot}CH_2Br$, be treated with two molecular proportions of ethylic sodiomalonate, the tetracarboxylate,—

$$(COOEt)_2CH{\cdot}CH(CH_3){\cdot}(CH_2)_4{\cdot}CH(COOEt)_2,$$

is produced. It appeared probable that if the disodium-derivative of this compound were treated with bromine a closed chain heptamethylene-derivative would result. This, however, was found not to be the case, the action taking place in some other manner not yet made out.

Discussion.

Dr. Armstrong said that the problem which Dr. Perkin and his associates were endeavouring to solve was one of great theoretical importance. In representing the compounds which had been described as derivatives of closed-chain hydrocarbons, they were undoubtedly formulating what would appear to be the simplest interpretation of the synthetical methods adopted; but there was little independent conclusive evidence to support their view. In several respects the behaviour of the compounds was by no means that of closed-chain derivatives; thus it was remarkable that the trimethylene-ring should be easily split by hydrogen bromide and by water, but not by bromine. If, however, a closed carbon chain could be split by such means, the conditions realised in the case of the trimethylene-compound described by Freer and Perkin were certainly those which would tend most to favour such a change. In illustration of the difficulty of determining whether a compound was saturated, the speaker referred to xeronic acid, which Fittig had represented as the derivative of a closed chain of 4 carbon atoms, but which has recently been proved to be a diethylfumaric acid. Assuming that the compounds described were closed-chain derivatives, the failure to obtain a hepta-methylene-derivative gave weight to Dr. Miller's objection to Dr. Kipping's argument, and justified the conclusion that the number of carbon atoms as well as position had to be taken into account.

Dr. Japp referred to the hydrocarbon prepared by Burton and himself from anhydracetonebenzil (*Chem. Soc. Trans.*, 1887, 423): it is highly probable that this is a tetra- or penta-methylene-derivative, and it is noteworthy that it does not undergo any change if heated with iodhydric acid and phosphorus at 150°.

66. "*The Composition of Shale-Spirit.*" By A. K. Miller, Ph.D., and T. Baker, B.Sc.

The authors have sought to determine (*a*) whether shale-spirit contains any higher olefines than those found in the liquid mixture of hydrocarbons from oil-gas, and (*b*) the constitution of the olefines, Armstrong and Miller having shown that heptylene was the highest hydrocarbon of the C_nH_{2n} series present in oil-gas products, and that all the olefines from oil-gas possess a normal constitution.

The shale-spirit was fractionally distilled, and the three fractions boiling respectively at 140° to 145°, 120° to 125°, and 75° to 85°, were examined by the method described by Armstrong and Miller (*Chem. Soc. Trans.*, 1886, 74). Each fraction was found to consist of paraffin to the extent of about 50 per cent, the remainder being partly olefine and partly less unsaturated hydrocarbons of unknown constitution. The bromine addition-compounds of the latter are to a large extent decomposed by distillation in a current of steam, yielding tarry products, whilst the olefine bromides distil over unchanged. After distilling the bromides under reduced pressure, the olefines were recovered by the zinc-copper couple; they were then fractioned; and finally the fatty acids produced by their oxidation with potassium permanganate were examined.

The results obtained show that not only the lower olefines, but also octylene and nonylene are present in shale-spirit. The nonylene was readily obtained in a state of comparative purity, and its oxidation-products indicated it to be the pure normal olefine, heptylethylene. The lower olefines were, however, more difficult to purify, and gave a more complex mixture of oxidation-products. The octylene fraction (b.-p. 120° to 122°), for instance, gave both heptylic and caproic acids (the latter in larger quantity), together with acetic and formic acids; and in the same way the hexylene fraction (65° to 70°) was found to yield more butyric than valeric acid, these being also accompanied by formic and acetic acids. In the same way as the production of heptylic and formic acids indicates the presence of normal octylene, the formation of caproic and acetic acids might be regarded as evidence that an isomeric octylene is also present; but this is not necessarily the case, as acetic acid appears to be a constant product of the oxidation of normal olefines, so that no definite conclusion can be drawn from its presence, especially as it is produced to a relatively small extent;

in fact, the authors consider that the caproic acid probably owes its origin to the presence of heptylene in the octylene, the separation of the lower olefines by fractional distillation being accomplished with difficulty unless very large quantities of material are dealt with.

It is noteworthy that, whereas in the manufacture of oil gas the paraffins are all but destroyed and no olefine higher than heptylene is obtained, shale-spirit, which is produced by the decomposition of paraffins at a much lower temperature, is rich in paraffins and higher olefines.

67. "*The Magnetic Rotatory Power of the Ethyl Salts of Maleic and Citraconic Acids and their Isomers.*" By W. H. PERKIN, Ph.D., F.R.S.

The result of the examination of the ethylic salts of maleic, citraconic, and itaconic acids show that in the magnetic field they affect polarised light like most substances of the kind differing by 2H from normal saturated compounds.

The author has already shown (*Chem. Soc. Trans.*, 1884, 561) that such unsaturated compounds have a greater molecular rotatory power than saturated compounds to the extent of a little more or less than 1·0; thus, the value for allyl is about 0·914 higher than that of propyl, and the value for oleic compounds is about 1·112 higher than that for corresponding saturated compounds. In the case of the acids under consideration the increase is a little higher still, as the following comparisons show:—

Ethylic maleate ..	9·647	Ethylic itaconate ..	10·630
„ succinate ..	8·380	„ methylsuccinate ..	9·347
Difference ..	1·267	Difference ..	1·283

Ethylic citraconate	10·499
„ methylsuccinate	9·347
Difference	1·152

The small difference between the molecular rotatory power of the itaconic and citraconic salts is undoubtedly due to the structure of the compounds being somewhat dissimilar.

The fumaric and mesaconic compounds afford very considerably higher values, thus:—

Ethylic fumarate ..	10·119	Ethylic mesaconate	11·269
„ succinate ..	8·380	„ methylsuccinate ..	9·347
Difference ..	1·739	Difference ..	1·922

From these results, maleic, citraconic, and itaconic acids may be regarded as ordinary unsaturated compounds related to succinic and methylsuccinic in a similar way that α-crotonic and oleic acids are related to butyric and stearic acids. Fumaric and mesaconic acids belong to a different class of compounds. The interpretation to be given to the very high molecular rotatory powers of these compounds is not at present evident. The results of this investigation do not appear, however, to be in favour of the formulæ lately suggested by Anschütz to explain the somerism of maleic and fumaric acids.

68. "*The Temperatures at which various Sulphates undergo Decomposition.*" By G. H. BAILEY, D.Sc., The Owens College.

On account of the use which is frequently made of sulphates in atomic weight determinations, it is important to ascertain to what temperature they can be heated without undergoing decomposition, as it is necessary to apply heat in order to dehydrate and expel adherent acid. The author heats the sulphate containing excess of acid, in the apparatus which he had previously described, at a known temperature—say 360°—till of constant weight; the temperature is then raised, and the heating continued, &c. For a considerable range of temperature the weight remains constant, but a point is ultimately reached at which further loss of weight occurs, indicating that the temperature has been reached at which the normal sulphate decomposes.

Zinc sulphate begins to decompose at 410°, bismuth sulphate at 405°; lead, magnesium and sodium sulphates are stable up to 500° at least. The behaviour of didymium sulphate is quite different from that of the other salts, and the limits of temperature within which it is stable are not sharply defined.

69. "*The Reaction between Sulphites and Nitrites of Metals other than Potassium.*" By EDWARD DIVERS, M.D., F.R.S., and TAMEMASA HAGA, F.C.S.

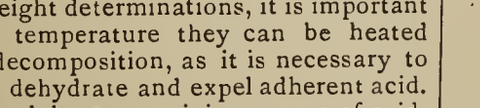
Referring to a recent paper by Raschig (*Ber.*, 1887, 584), the authors state that they have for a long time been aware that hydroxylamine is producible from various nitrites by the action of sulphurous acid and sulphites, and have only delayed making this known that they might at the same time communicate the results of their examination of the stages of the reaction when sodium salts are used. Fremy entirely failed to prepare sodium salts corresponding with the potassium compounds he has described. The authors, however, have succeeded in preparing sodium salts which are unmistakably compounds of the simpler acids of which Fremy prepared potassium salts.

On mixing solutions of sodium sulphite and nitrite slight heat is developed (when metasulphite is substituted the rise in temperature is more marked), and the mixture increases in alkalinity; when two formula weights of sulphite to one of nitrate are taken, all sulphite and nitrite as nearly as possible, cease to exist as such, in about ten day's time. For some time after mixing sulphite can be precipitated as barium salt, nitrite being left in solution; but when the interaction is complete, the barium precipitate is that of a hydroxylaminesulphonate free from sulphite and sulphate (traces excepted), and the mother-liquor contains a barium aminesulphonate and very little hydroxylaminesulphonate. On dissolving the barium precipitate in acid, no evidence of the presence of hydroxylamine is obtained until the liquid has been heated: a precipitate of barium sulphate is then produced, much hydroxylamine being then formed. The barium precipitate is probably the slightly soluble salt of hydroxylaminedisulphonic acid, and the soluble barium salt, that of aminetrisulphonic acid, which on heating becomes di- and mono-sulphonic acids, sulphuric acid separating.

By acidifying and heating a mixture of sodium sulphite and nitrite in suitable proportions, the authors have obtained almost all the nitrogen of the nitrate as hydroxylammonium sulphate. Metasulphite appears to be still better suited than the normal sulphite for the preparation of hydroxylamine.

70. "*The Action of Acetyl Chloride on Acetoximes.*" By VICTOR MEYER and A. W. WARINGTON, B.Sc.

The authors find that if the acetoxime obtained from isopropylketone and hydroxylamine be treated with acetyl chloride at a low temperature, the corresponding acetate is formed; but that if the temperature be allowed to rise the product is an isomer of the acetoxime. This isomer is a solid, and crystallises in colourless needles; it melts at 102°, and boils at 210°. On hydrolysis it yields isobutyric acid and isopropylamine, and it may be prepared from isobutyric chloride and isopropylamine: an isomeric change therefore takes place, the nature of which may be seen on comparison of the formulæ:—



Diisopropylacetoxime. Isopropylisobutyramide.

No such isomeric change occurs on similarly treating dipropylacetoxime, the corresponding acetate being the only product.

71. "*Sulphinic Compounds of Carbamide and Thio-carbamide.*" By GEORGE MCGOWAN.

The compounds described are:—

(1.) $(CSN_2H_4)_2 \cdot (Cl_3CSO_2)_2$ = dithiocarbamide ditrichloromethylsulphinate.

(2.) $CSN_2H_4 \cdot Cl_3CSO_2H$ = thiocarbamide trichloromethylsulphinate.

(3.) $CON_2H_4 \cdot Cl_3CSO_2H$ = carbamide trichloromethylsulphinate.

(4.) $CSN_2H_3 \cdot Cl_3CSO_2$ (?) = trichloromethylsulphinylthiocarbamide.

The first of these is prepared from ammonium trichloromethylsulphinate and dithiocarbamide dichloride; the second by dissolving equimolecular proportions of thiocarbamide and ammonium trichloromethylsulphinate in alcohol, and adding a slight excess of a concentrated solution of hydrogen chloride; the third is prepared in the same way as the second, avoiding water, which decomposes it, the fourth is obtained together with dithiocarbamide dichloride by the action of trichloromethylsulphonic chloride on thiocarbamide.

72. "*Anacardic Acid.*" By Dr. S. Ruhemann and S. Skinner, B.A.

Anacardic acid was originally obtained by Staedler from the oil contained in the shell of the fruit of *Anacardium occidentale;* he assigned to it the formula $C_{44}H_{32}O_7$ (C = 6). The authors find that it is an hydroxycarbolic acid of the formula $C_{22}H_{32}O_3$. They describe several salts, and give the results of their analyses.

NOTICES OF BOOKS.

Notes and Formulæ for Mining Students. By J. H. Merivale, M.A. London: Crosby Lockwood and Co.

This work addresses itself mainly to the student of coal-mining. The author begins his introduction with the statement:—I am frequently asked by students to advise them as to the course of study they should pursue in order to pass the Colliery Manager's examination," and he remarks with the utmost justice that " the successful English mining engineer of the future will have to be (as his continental rival long has been) not only a good practical man, but a man of science as well."

As a matter of course very much of the instruction here given will be available for students who look forward to a position in other departments of mining, such, *e.g.*, as the sections on strength of materials, on timber, explosives, machinery, prime movers, boilers, the transmission of power, &c. For this last purpose Mr. Merivale speaks in favour of compressed air, as the most handy form of transmission for mining purposes, having the collateral advantages of improving the ventilation and cooling the mine. He does not think that in mines where the maximum distance is only about three miles, electricity is likely to compete successfully either with air or with wire ropes, though it will be available for the transmission of power to very great distances. The author is in favour of electric lighting below ground as far as stationary lights are concerned. The portable electric lamps for miners hitherto constructed are too costly and too heavy. He considers that there is no danger from shocks if a continuous current of not more than 200 volts or an alternating current of not more than 75 volts is used. He points out, however, that there is a risk of sparks firing gas at the commutator or at the two ends of a broken wire.

The cost of sinking and fitting up a shaft will somewhat astonish the general reader. If there is but little water it is given as £50 per fathom for 100 fathoms. If there is a good deal of water the cost may be doubled.

On the other hand, the London public who are compelled to pay 20s. per ton and upwards for coal may be edified to learn that the total cost of coal, delivered into waggons at the pit, including labour underground and on the surface, rent, rates, fuel, agency, depreciation, and interest, is only about 5s. per ton " under ordinary conditions of trade," so that there is an exceedingly large margin left for carriage and for profit!

We scarcely feel satisfied with a table given of the estimated extent of the principal coal-fields of the world. That of China is given as only about one-tenth that of the United States, though we have heard it estimated as equal to if not exceeding the latter in extent. Nor is there any mention of the South African field (Natal and the Orange Free State) which is considered as more extensive than that of Great Britain. But here, as well as in China, much remains to be done before the boundaries of the coal-areas are accurately mapped out.

Mr. Merivale may justly congratulate himself on having produced an exceedingly useful manual.

Revista Pharmaceutica do Instituto Pharmaceutico do Rio de Janeiro. Nos. 7, 8, and 9.

A pharmaceutical journal, written, of course, in the Portuguese language. The most important matter contained is a series of articles entitled " Pharmaceutical Studies of the Plants of the Brazilian Flora," which, doubtless, is far from having been as yet thoroughly explored.

CORRESPONDENCE.

SOFTENING MAGNESIAN WATERS.

To the Editor of the Chemical News.

Sir,—Mr. Wanklyn says, in his letter which appeared in the last issue of the Chemical News (vol. lvi., p. 11), that " my conclusion, which will be shared by chemists, is that magnesian waters offer no special obstacles to Clark's process."

I wish simply to say that this is not my conviction, and that in fact I know, *personally*, of cases in which the Clark process has had to be abandoned.

If lime-water be added in large excess, the hydrate of magnesium which is thrown down clogs the filters so badly that the water ceases to pass through after two hours' use.

If, instead of using clear lime-water, we use a slightly milky lime-water, a larger quantity is thrown down, and the precipitate is granular and allows filtration to go on better; but even in this case the improvement has been so slight that the partial removal of magnesian salts has not justified its adoption.

I do not deny the correctness of Mr. Wanklyn's results in the analyses of the softened water referred to. I suppose, if anyone took the trouble to operate on a highly-charged magnesian water, the removal of magnesia might be carried to the extent Mr. Wanklyn mentions.

We require a proof of its feasibility when operating on an ordinary water supply.—I am, &c.,

Thomas T. P. Bruce Warren.

Tamworth Villa, Earlham Grove, Forest Gate.

Simultaneous Precipitation of Mixtures of Iodates and Sulphates of Barium Salts.—M. Chroustchoff.—On precipitating a mixture of potassium iodate and sulphate dissolved in water, by the solution of a barium salt equivalent in quantity to one of the two potassium salts, we obtain precipitates very valuable in composition. The distribution of the base between the two acids seems at first an irregular and very complex phenomenon, but on attacking it analytically and colorimetrically we recognise the different phases, successive and simultaneous, of the precipitation of mixtures.—*Comptes Rendus*, civ., No. 24.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 24, June 13, 1887.

On the Earthy Phosphates; Remarks on a Communication by M. Joly.— M. Berthelot.— The experiments of M. Joly, read in the present session, supply novel and interesting data for our knowledge of the earthy phosphates. The author had previously established the existence of two distinct states of the (alkaline) earthy phosphates, a colloidal and a crystalline, the latter corresponding to a greater liberation of heat. Among the crystalline phosphates, M. Joly distinguishes the simple and the double phosphates.

Note on the Residues resulting from the Action of Acids upon the Alloys of the Platinum Metals.— H. Debray.—The author has previously shown that three cases are here possible. We may either obtain the platinum metal in a crystalline state, or a well-defined alloy or residues containing a noteworthy proportion of water and of oxygen, and even of nitrogen if the acid employed has been the nitric. The first case occurs with osmium alloyed with zinc or tin, and with ruthenium and iridium alloyed with lead. The action of hydrochloric acid upon zinc and tin (or that of nitric acid upon lead) is much facilitated by the presence of the platinum metals. The phenomenon is the same when the precious metal, in place of simply dissolving in the tin, &c., forms with it a compound less readily attacked than the tin itself. If there has taken place a combination of the precious metal and of the common metal, attended by a lively disengagement of heat, there is formed, under the influence of the special currents set up in the acid liquid, a complex body containing oxygen, nitrogen, and water.

Fluorescences of Manganese and Bismuth.—Lecoq de Boisbaudran.—This paper does not admit of useful abridgment.

Variations of the Absorption Spectra of the Compounds of Didymium.— Henri Becquerel.— In recent communications the author has shown that the principal directions of absorption of certain bands observed through crystalline compounds of didymium, enable us to recognise in these crystals, by means of their optical properties, a mixture of different substances. Further, that on dissolving these crystals in water the unequal displacements or the disappearance of the same bands show that a certain number of these substances are compounds unequally affected or even destroyed by water. As among these optically different bodies we find all those which chemical analysis has hitherto enabled us to isolate, we must ask if all are distinct simple bodies, or if, for the most part, they are multiple salts or sub-salts of a more restricted number of simple bodies at different degrees of oxidation? This latter hypothesis is the one to which we are led by the experiments described below. It is interesting to remark that the absorption spectra of dilute solutions of various compounds of didymium, sulphates, nitrates, chloride, platino-cyanide, differ very little from each other, whilst the absorption-spectra of these same compounds when crystalline are respectively very different. When by means of graduated ignitions we expel progressively first the water, then a part and finally the whole of the acid of one and the same salt of didymium, we obtain different products, some transparent and some pulverulent and opaque, but whose absorption spectra can yet be observed by reflection. We see, then, in each of these products, different absorption bands appearing and disappearing. The author then gives a very extensive table of the approximate value of the mean wave-lengths of the principal bands of the absorption spectra thus obtained. When didymium nitrate has undergone igneous fusion, it still shows most of the bands observed in crystalline compounds. If the ignition is continued, keeping the temperature below dull redness, it loses a part of its nitric acid and is transformed into a white powder, slightly rose-coloured or yellowish. This substance, which gives the characteristic spectrum indicated above, seems to be a basic nitrate. By ignition at a higher temperature it continues to lose nitric acid. On igniting this sub-nitrate in a current of pure dry hydrogen, and raising the temperature from cherry-red to an orange-red we obtain products which give a series of different spectra. It is interesting to mention that in the spectra obtained by the successive transformations of one and the same compound series of bands, seem to be transferred bodily from one spectrum to another, so that the variation of the number of luminous vibrations, or of the inverses of the wave-lengths of the corresponding bands, is a number approximately constant for each series. Each spectrum presents several of these series with different constants. The characteristic bands of several of these compounds coincide with the variable bands of the spectra of the crystals. The series of sulphates gives results of the same order as the series of the nitrates.

Researches on the Tri-Metallic Phosphates.—A. Joly.—The author has studied the tribasic phosphates of strontium, calcium, and barium.

Metallic Vanadates.—A. Ditte.—An account of the vanadates of magnesium, barium, calcium, nickel, cobalt, zinc, copper, lead, silver, and cadmium.

Hydrochlorates of Chlorides: Ferric Chloride Hydrochlorate.— M. Engel. — The author has formerly shown that hydrochloric acid precipitates chlorides from solution, 1 mol. of hydrochloric acid displacing approximately 1 mol. of chloride. There are, however, exceptions to this law. The author has prepared two definite hydrochlorates of zinc chloride and a stannous chloride hydrochlorate. Hydrochloric acid does not precipitate the solution, however concentrated, of ferric chloride. Dry hydrochloric acid liquefies the two hydrates $Fe_2Cl_6+12H_2O$ and $Fe_2Cl_6+5H_2O$.

The Influence of Heat and Light upon Chlorination. — Henri Gautier. — This investigation refers to chloro-substitution in compounds belonging to the aromatic series. M. Schramm has recently taken up the study of halogenous substitutions in the hydrocarbons; he finds that not only heat intervenes to determine the formation of such or such an isomer, but that even at 0° substitution products can be obtained in the chains on operating in solar light. M. Gautier therefore has examined if these rules, founded upon observations relating only to the hydrocarbons, are applicable also to substances of a different chemical function, and he has chosen for his experiments an acetone methylbenzoyl. He finds that whatever may be the temperature prevailing substitution always takes place in the chain, and, contrary to what takes place in the hydrocarbons, light has no influence on the nature of the reaction, affecting merely its speed. M. Gautier therefore asks if the presence of an electro-negative group in the aromatic nucleus prevents an element of the same nature from being substituted for the hydrogen; if this substitution could not be effected in presence of aluminium chloride; if the reaction would be wanting among compounds of analogous structure, but containing hydrogen only in the nucleus, such as benzoyl chloride, benzophenone, &c.

On Sebacedinitranilide.—G. Gehring.—Sebacedinitranilide crystallises from water in fine needles; from ether in large prisms with a square base, melting at 116°, and capable of sublimation. It is white, very sweet, but does not reduce cupro-potassium tartrate.

On Certain Derivatives of Inosite.—M. Maquenne. —Inosite is a hexatomic alcohol, of a simple function,

derived from hexamethylene. It ought to be regarded as a mannite with a closed chain, and not as a polyphenol.

On Pterocarpine and Homopterocarpine, two Crystalline Principles obtained from Red Santal-wood.—MM. Cazeneuve and Hugounenq.—From the wood of red santal (*Pterocarpus Santalinus*) there have been already isolated santaline, the colouring-matter and a crystalline compound, santal, isomeric with piperonal. Pterocarpine is a white crystalline body, insoluble in water and in cold alcohol, slightly soluble in boiling alcohol and in ether. It dissolves in chloroform, from which it separates in splendid clinorhombic prisms. It softens and melts at 152°, taking a yellow colour. This compound is insoluble in acids and potassa lye even at a boil. Homopterocarpine is a white crystalline substance, soluble in ether, chloroform, benzene, and carbon disulphide. From ether it crystallises in fine needles.

A Compound of Chromic Acid with Aniline.—Ch. Girard and L. L'Hote.—An aniline chromate can be prepared only by the double decomposition of an alkaline bichromate and aniline hydrochlorate, both solutions as cold as possible. The compound is sparingly soluble in cold water, and is decomposed by boiling water. If moist it is attacked by air and light, but when dry it is permanent. If treated with hot water it produces various colouring-matters, similar to Perkin's mauveine.

The Composition of Butters of Different Origins.—E. Duclaux.—The author questions the constancy of the proportion of volatile fats in genuine butters. He finds that the sum of the butyric and caproic acids ranges from 7·95 to 5·77 per cent. The greatest uniformity is found in the butters of Isigny. In this district there is the greatest uniformity in the race and in the conditions of alimentation. M. Duclaux thinks that, in addition to the care employed in making and preserving the butter, the race of the cows and the food supplied, the geological nature of the soil, and the climate, are not without influence.

On Fermentations caused by the Protoplasm of an Animal recently Killed.—M. Fokker.—This paper deals with the question of heterogenesis.

Bulletin de la Société Chimique de Paris.
Vol. xlvii., No. 7, April 5, 1887.

Latent Heats of Dissociation.—H. Le Chatelier.—Already noticed.

On Active Camphene and Borneol Ethylate.—G. Bouchardat and J. Lafont.—Not adapted for useful abstraction.

On a Tannin contained in the Berries of the Mountain Ash.—C. Vincent and M. Delachanal.—The juice of ripe mountain-ash berries contains, besides sorbine and glucose, an astringent principle, having a very acid reaction. Caustic alkalies and ammonia turn it an intense gold-yellow, which disappears on acidification. It does not precipitate solutions of alum; it reduces salts of silver in heat, precipitates copper acetate of an olive-green, turns a very intense dark green with ferric salts, which the alkalies and ammonia alter to a reddish brown. With neutral lead acetate it gives a light yellow precipitate; with the sub-acetate a very pure lemon-yellow. It does not precipitate gelatin. On distillation it gives a thick brown liquid, rich in pyrocatechine, and leaves a voluminous charcoal. This tannin approximates closely to morintannic acid, and especially to caffeotannic acid, but differs from them in several respects. The authors propose to name it sorbitannic acid.

Water of Crystallisation of Alums.—P. de Boissieu.—An examination of the results of M. Maumené. The author maintains that under ordinary conditions alum crystallises with 24 mols. of water, and not with 29. He does not regard the existence of a lower hydrate as probable.

Action of Sulphuric Acid upon the Solubility of Sulphates.—R. Engel.—Already noticed.

An Organic Acid obtained by the Action of Alcoholic Potassa upon a Mixture of Chloroform and of Acetone.—R. Engel.—The author has obtained an acid, $C_{11}H_{20}O_6$, and has examined its lead and zinc salts.

Analysis of Coffees.—L. Padé.—The author points out two novel frauds in the coffee trade. Raw coffee which has been sea-dipped is washed, decolourised with lime-water, washed anew, dried rapidly, and coloured either by a slight roasting or by dyeing with azo-oranges. By such manipulations green Santos coffees are made to pass as Java growths, worth about 25 per cent more. Dealers have lately conceived the idea of restoring to coffees the 17 to 19 per cent of weight which they lose in roasting. This is done by exposing the roasted beans to steam, and coating them with glycerin, palm oil, or even vaseline (!), to prevent evaporation. Beans so manipulated, instead of being hard and brittle, become elastic and horny under the teeth.

Vol. xlvii., No. 8, April 20, 1887.

Presence of Levo-Rotatory β-Oxybutyric Acid in the Blood of a Diabetic Patient.—L. Hugounenq.—Külz, Minkowski, and Stadelmann have observed the presence of a large proportion of levo-rotatory β-oxybutyric acid in the urine of certain diabetic subjects. The author has had the opportunity of verifying this observation as far as urine is concerned, and of further ascertaining that the blood of such a subject contained also a considerable quantity of this acid.

Qualitative Detection of Sulphites in presence of Hyposulphites and Sulphates.—A. Villiers.—This paper has been noticed under the *Comptes Rendus*, in which it appeared almost simultaneously.

Researches on Barium Phosphates: Application to Acidimetric Analysis.—A. Villiers.

Researches on Roussan's Process for the Treatment of "Phlegms."—M. l'Abbé L. Godefroy.—The author considers Roussan's process as simple, inexpensive, and deserving the attention of chemists and industrialists.

On Fluorescent Matters.—Lecoq de Boisbaudran.—The author considers that manganese compounds do not exalt or strengthen a pre-existing power of fluorescence, but produce it where it had no previous existence.

MISCELLANEOUS.

The Æolus Waterspray General Ventilating and Electrical Engineering Company.—On Monday and Tuesday last the Æolus Waterspray Co. gave an interesting exhibition of the action of their patent ventilators, at their premises in High Holborn. This system of ventilation was patented several years ago, and is now becoming widely known and appreciated throughout the country. The method employed for inducing a current of air is, as its name implies, by a spray of water squirting through a nozzle of peculiar construction, so arranged that it can be flushed in a few moments whenever necessary, simply by giving a few turns to a screw. The action of this spray is somewhat similar to that of a Bunsen filter-pump or a Giffard injector, the rush of water dragging the air after it. One gallon of water is said to be sufficient to move 1000 cubic feet of air, which is much more than could be done if the power used was applied to driving a fan for the same purpose. Besides ventilating apparatus, this company supply all kinds of electrical machinery and appliances for electric lighting. Their mechanical or acoustic telephone is by far the simplest and most effective telephone for short distances, such as a mile or so; it is free from all patents, does not require an electric battery to work it, and is very cheap, three points in its favour which should strongly recommend it.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Chemical Manures.— Wanted the titles of any good *practical* books on chemical manure making.—SUPERPHOSPHATE.

Agricultural Chemistry.—I am leaving this country in two or three weeks for Fiji, in the capacity of chemist to a sugar estate there. 1st. Can any private individual purchase or procure copies of reports of experiments made on the sugar-cane as to its yield of sugar under different manurial, &c., treatment? 2nd. Could you name any good works on Agricultural Chemistry in the German language, few being in our English? I am of course acquainted with Ville's "Artificial Manures." 3rd. Where or how could I procure a Chamberland filter, which is seemingly the best? My purpose being to attempt the purification of the drinking water, which you will know is credited or rather blamed for causing dysentery.—ROBERT DAVIDSON.

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Notice to Contributors of Memoirs.—Authors are reminded that, under an arrangement dating from 1871, the acceptance of Memoirs, and the days on which they are to be read, are now as far as possible determined by Organising Committees for the several Sections before the beginning of the Meeting. It has therefore become necessary, in order to give an opportunity to the Committees of doing justice to the several Communications, that each Author should prepare an Abstract of his Memoir, of a length suitable for insertion in the published Transactions of the Association, and the Council request that he will send it, together with the original Memoir, by book-post, on or before August 3rd, addressed thus:—"General Secretaries, British Association, 22, Albemarle Street, London, W. For Section ——." Authors who comply with this request, and whose Papers are accepted, will be furnished before the Meeting with printed copies of their Reports or Abstracts. If it should be inconvenient to the Author that his Paper should be read on any particular days, he is requested to send information thereof to the Secretaries in a separate note.

Reports on the Progress of Science, and of Researches intrusted to individuals or Committees, must be forwarded to the Secretaries, for presentation to the Organising Committees, accompanied by a statement whether the Author will be present at the Annual Meeting.

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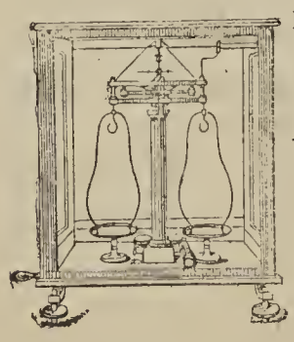

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THE CHEMICAL NEWS.

Vol. LVI. No. 1443.

ON METALLIC MANGANESE.

By THOMAS T. P. BRUCE WARREN.

A short time ago I had occasion to examine a specimen of commercial metallic manganese. I found that it was not visibly affected by a powerful compound horse-shoe magnet. I then carefully rubbed some to a very fine powder in an agate mortar, as I had reason to suspect the presence of particles of iron when powdered in a steel mortar.

A little of the powder was sprinkled on a thin sheet of well-glazed paper, placed over the same magnet. When the paper was gently drawn laterally or lengthwise to the direction of the poles, a few particles were seen to be strongly drawn out from the rest, whilst the greater portion seemed unaffected; this was evidently not due to mere differences of inertia in the particles.

A steel pen nib was then strongly magnetised, and the point drawn through the powder; the attracted particles gathered in small tufts and behaved as though they were capable of faintly attracting other particles.

It seemed to me an interesting matter to endeavour to account for this unexpected result. Reference to "Watts's Dictionary" (art. "Manganese") strengthened my perplexity.

Manganese made by Brunner's method is said to be non-magnetic, and as this statement occurs in "Watts's Dictionary" with the editorial query, my curiosity was, so far, at least pardonable.

Ten grms. of the metal were dissolved in dilute hydrochloric acid with a piece of platinum foil thrown in, so as to expedite the solution. A residue amounting to about 12 per cent was left undissolved, consisting apparently of silica, carbon, and fluor-spar; the whole was transferred to a porcelain dish, so as to burn off the carbon, when a copious inflammable vapour was given off, burning with a strong smoky flame.

The presence of this inflammable vapour may admit of explanation in this way, that the oxide, flux, and reducing materials were heated in the vapour of light petroleum so as to avoid the ingress of atmospheric oxygen; or, as Deville has pointed out, it may arise from the rock oil adhering to the sodium, which is used by Brunner in its preparation from the chloride.

"The metal obtained from the chloride or fluoride by Brunner's process has also the aspect of cast-iron, and is very brittle, but it is not magnetic. (What power was used in testing it?)"*

As Sir William Thomson has recently pointed out that petroleum is capable of affecting a magnet, I thought that the presence of this vapour might have something to do with its magnetic indifference. The powdered metal was carefully heated for some hours over a gas blower in a piece of combustion tubing, through which a current of hydrogen was passed, and the metal allowed to cool in a current of the same gas. A slight increase in weight was observed, and the portion of the tube near the porcelain boat was dimmed by the action of fluorine or a volatile fluoride, but no condensed petroleum was collected, although the smell was distinctly perceptible.

I must remark, however, that this result of heating is unsatisfactory, and showed that a little air must have crept into the tube. The experiment should be repeated with the necessary precautions to guard against the intrusion of air or moisture. This heating did not produce any marked change in its magnetic behaviour.

The hydrogen which was given off when the metal was dissolved in hydrochloric acid gave a peculiar smell, which at the time was attributed to electrolytic hydrogen. I have reason, now, for believing that the smell was due to the evolution of a carbide of hydrogen.

Since putting these notes together, I have examined this manganese by the method given in the Chemical News (vol. lvi., p. 15), and I find that it is distinctly magnetic, although decidedly low. I cannot say, from experience, whether it is abnormal in this respect to manganese prepared by any other process. I have always been under the impression that manganese is but feebly magnetic.

The chemical treatment of this subject has lead to the important conclusion that, knowing the susceptibilities of two or more materials, we can calculate what may be expected when they are mixed together.

Manganese, chromium, cerium, titanium, and osmium are placed by Faraday in the magnetic class, because certain of their compounds exhibit the ordinary magnetic relations.

When we consider that with a delicate balance we can detect a force amounting only to 1-500th grain, we must admit we have at once a simple and delicate method of measuring magnetic forces. A balance turning with 1-100th grain, or even more, will be delicate enough for most purposes.

* Watts's Dictionary," ("Manganese"), vol. iii., p. 802.

EXPERIMENTS ON THE VOLUMETRIC ESTIMATION OF COBALT IN PRESENCE OF NICKEL.

By NORMAN McCULLOCH.

While engaged in examining a new process for volumetrically estimating manganese,—a method founded on the precipitation of the manganese in presence of peroxide of hydrogen with caustic soda, boiling off excess of hydroxyl, and subsequent treatment with standard ferrous salt,—I had occasion to observe that the principle of the process might be applicable to the determination of cobalt in presence of nickel, the former metal precipitating apparently as the sesquioxide, the latter as the green hydrated protoxide; and, accordingly, the composition and constancy of the cobaltic hydroxide so precipitated I proceeded to carefully investigate.

But the reliability of the process to exactly determine manganese I found, as the test of repeated experiment, to be unsatisfactory. The results varied nearly 3 per cent from the mean, and the fact was revealed that hydrated binoxide of manganese in reaction with peroxide of hydrogen undergoes partial reduction, and approximates in composition to the formula Mn_7O_{13}.

An experience practically analogous awaited my efforts to found a volumetric analysis of cobalt on the principle above alluded to. Almost every conceivable mode of application failed to eliminate a variation of nearly 2 per cent from the mean of its indications, and a cobalt oxide in presence of hydrogen peroxide is oxidised, or reduced, as the case may be, to an oxide of probably complex constitution, and representable by the empirical formula $Co_{13}O_{19}$.

Another fairly promising field of inquiry suggested in the treatment of the cobalt in ammoniacal solution with peroxide of hydrogen, and subsequent estimation of the oxygen taken up. The solution, saturated with ammonium chloride and strongly alkaline, was treated with the oxidant, and decomposition of excess of same assisted by heating with ferric hydroxide.

Boiling with ferrous oxide, acidifying, and titrating with standard bichrome, I found the most practical way of decomposing and estimating the cobaltamine salt. With these experiments, as with the others preceding, the results were occasionally concordant, and often enough so

to induce careful inquiry for a reliable application of the principle. But the measure of success was much the same as before. Cobaltamine salts are, as other chemists have asserted, partially unstable in warm alkaline solution. I have failed to obtain them stable in acid solution, and with prolonged boiling in presence of ferric salt they reduce entirely to the cobaltous state.

Further inquiry was now confined to one or two of the more likely suggestions current in chemical literature, although I confess to a dubiousness that in such any reliable volumetric method of determining cobalt in presence of unknown proportion of nickel would be found. At any rate, with the better examined processes their untrustworthiness in presence of much nickel is admitted, and re-investigation of same I considered profitless. The processes suggested for cobalt in pure solution alone are of no practical consequence, and, as already implied, the applicability of all others in presence of nickel is open to doubt, and regarded as such, I think, by chemists in general. I have considered only the methods whose merits or demerits are not definitely stated, and which, in fact, seem to lack the assurance of serious examination; and with my purpose so limited I have deemed an investigation of the methods devised by Dr. Fleischer and E. Donath as sufficiently comprehensive.

The various tests have been made with the sulphates of nickel and cobalt, the purity of which had been duly established. The sulphate of nickel is purchasable pure, but the cobalt salt rarely so; and the method adopted for eliminating its variable content of nickel and manganese I may briefly describe:—

The aqueous solution of the sulphate of cobalt was treated with potassium cyanide until the precipitate first thrown down had re-dissolved. Nitric acid was now added to the liquid until a yellowish turbidity appeared, and then bromine till the solution became strongly tinged. On alkalinising the hot liquid with caustic soda, and boiling off any ammonia if present, all the nickel and manganese, also a little cobalt, precipitated, and was removed by filtration. The filtrate evaporated to dryness, and fused in a platinum capsule, gave as the resultant a mixture of alkaline salt and oxide of cobalt, and on lixiviating the mass with water the former dissolved out, and the latter was thrown on to a filter and well washed. The filter and contents were ignited, dissolved in acid, and, after considerable dilution, precipitated with ammonium sulphide. The sulphide of cobalt was washed by decantation with several gallons of boiling distilled water, and then removed to a basin to be evaporated to dryness with nitric-sulphuric acid. The residue, dissolved in water and filtered, was re-evaporated, and ignited in muffle at low red-heat, to complete expulsion of free sulphuric acid.

In the product so obtained, and judging from the ordinary tests, the only detectable impurity was traces of ferric sulphate.

The other standard reagents comprised a bichrome-solution, containing, per 100 grains of its volume, 0·55 grain pure potassium bichromate; and a solution of ferrous sulphate in dilute sulphuric acid, sp. gr. 1·14, and equivalent bulk for bulk to the standard bichrome just mentioned. One grain of the iron solution would consequently be equal to 0·00655 grain cobalt,—that is to say, to the oxydimetric value of cobalt considered as the sesquioxide. These solutions were delivered from burettes graduated to fifths of a div. (10 grains), but measurable to tenths, and the iron solution was standardised under conditions comparable with the actual experiments.

The use of these standard reagents will be indicated in the following description of Fleischer's process, and of its modification proposed by E. Donath:—

The nickel and cobalt in acid solution are precipitated with sodium hypochlorite and caustic soda, and the black sesquioxides boiled in the same liquid with excess of chlorine or bromine, to ensure their thorough oxidation. They are filtered, washed, and dissolved in excess of standard ferrous sulphate, and the non-oxidised iron titrated with permanganate (or with bichrome, as in my own experiments).

To estimate the cobalt alone, and to arrive in addition at the nickel by difference, Dr. Fleischer, in another experiment, boils the mixed hydroxides with a 3 per cent solution of ammonia. The nickel sesquioxide is reduced to nickel protoxide without the cobaltic hydroxide undergoing a corresponding change, and so in the subsequent operation the cobalt alone determines the oxidation of the iron.

E. Donath separately estimates the cobalt by precipitating a portion of the original solution with excess of caustic soda, adding iodine, and heating to the boil. The cobalt protoxide is oxidised to the sesquioxide, but the nickel protoxide remains without change.

The authors have described their methods in rather general terms, but I shall proceed to a more detailed consideration of my own experiments.

The cobalt solution containing 0·05 per cent of the metal was heated to the boiling-point, and for every grain of cobalt taken an addition of 1 oz. of strong bromine water made. Calcium carbonate in excess was added, and, on boiling for a minute or two, the precipitated oxide allowed to settle in the amber-coloured liquid. It was thrown on to a filter supported on a glass funnel provided with a syphon tube, and repeatedly washed with boiling water until the washings had long ceased to show an oxidising constituent. The filter and contents were then removed to a basin, and titrated with the iron and bichrome solutions.

I have calculated the oxygen contents of the precipitate to its oxydimetric equivalent of cobalt as the sesquioxide, and have appended a few of the results in Table I.

TABLE I.

Co taken.	Co ound.
1·89	2·08
,,	2·03
,,	2·05
,,	2·01
,,	1·98
3·79	3·91

These, it will be seen, as well as others I have thought unnecessary to give, are decidedly in excess of the truth, and that to an extent unaccountable by ordinary error of experiment.

In several cases zinc salt was added to the cobalt solution previous to its precipitation, and thus making the procedure similar in principle to Pattinson's well-known volumetric method for manganese. Yet, with this modification, the results still varied and exceeded the truth. It appears to me that for an adequate explanation of these facts we must assume the precipitation under the conditions of the process of "higher" oxygen compounds of cobalt than the sesquioxide.

Calculating from the experiment heading the list, the comparison of the precipitate might be represented as $4Co_2O_3+CoO_2$; but of course compounds intermediate between the binoxide and sesquioxide may exist. It is also noteworthy that oxides of nearly similar composition were obtained by submitting a mixture of cobalt sulphate and "magnesia mixture" ($5NaHO+3MgO$) to the red heat of a muffle. These and the hydrated oxides are practically stable in water and aqueous solutions of caustic soda, at their boiling temperatures.

It will be seen that the use of calcium carbonate in the above experiments is a slight departure from Fleischer's own procedure, but considered by me as more likely to effect the uniform precipitation of the cobalt. Still the alkalinisation of the original solution with caustic soda, and boiling of the precipitated liquid with excess of bromine, yielded results in practical agreement with those of Table I.

With the use of caustic soda as precipitant there is rendered evident, in the brisk effervescence of the preci-

pitated liquid, that peculiar and so-called "catalytic" decomposition of hypobromide into oxygen and bromide through the influence of cobaltic hydroxide.

I have already asserted that the higher oxides of cobalt in reaction with peroxide of hydrogen suffer reduction to the lower oxide $Co_{13}O_{19}$. It would seem that in presence of neutral or alkaline solutions of hypochloride or hypobromite they experience a like loss of oxygen; and the results of Table II. were obtained by boiling the precipitate with hypochlorite or hypobromite in absence of free chlorine, bromine, or acid.

TABLE II.

Cobalt taken.	Oxygen found.	Theory for Co_3O_4.	Theory for $Co_{13}O_{19}$.
1·89	0·7624	0·7720	0·7522
1·89	0·7624	0·7720	0·7522
3·79	1·5401	1·5480	1·5084
3·79	1·5124	1·5480	1·5084
3·79	1·5138	1·5480	1·5084

These results are rather in excess of the theory for $Co_{13}O_{19}$, but in all probability particles of the precipitate will escape the reducing action of the liquid.

It has evidently been overlooked by Dr. Fleischer, in his recommendation regarding the use of ammonia to reduce nickel peroxides, that the peroxides of cobalt themselves are subjected to a slight reduction, and the reduced product I find representable by the formula $Co_{13}O_{19}$. Furthermore, if the process devised by E. Donath had been subjected by its author to an examination, doubtless the fact would have been revealed that this oxide, $Co_{13}O_{19}$, or at least one with nearly the same proportion of oxygen, is the only cobalt oxide stable in presence of free iodine or salts of hydriodic acid.

If we treat the "peroxides"—designating by this term the oxides precipitated by calcium carbonate in a bromine-cobalt solution—with a boiling aqueous solution of iodine, they suffer reduction to the extent shown in Table III.c and the iodine is proportionately converted into iodi acid.

I show two experiments as typical of others:—

TABLE III.

Cobalt taken.	Oxygen found.	Theory for $Co_{13}O_{19}$.
1·89	0·7562	0·7522
1·89	0·7596	0·7522

If a boiling iodine-cobalt solution be precipitated with caustic soda, and afterwards or not treated with excess of iodine, an oxide is obtained excessively difficult to filter, and necessitating the addition of caustic soda to the wash-water to make the washing at all practicable. In several analyses its composition varied from—

$Co_{13}O_{19}(=6Co_2O_3+CoO)$ to $Co_9O_{14}(=Co_2O_3+CoO_2)$,

and I can only explain the differences by the probable difficulty of freeing the precipitate from traces of iodic acid.

On the other hand, by boiling the "peroxides" with 50 grains or so of potassium iodide, for ten minutes or longer, the composition of the readily filtered and washed precipitate was remarkably uniform, and, as seen from Table IV., still further indicative of the existence of cobalt oxide or oxides of high molecular weight.

TABLE IV.

Cobalt taken.	Oxygen found.	Co calc. from Oxygen as $Co_{13}O_{19}$.	Co calc. from Oxygen as Co_3O_4.
1·89	0·7596	1·94	1·79
1·89	0·7583	1·93	1·80
3·79	1·5138	3·85	3·57
5·69	2·2700	5·77	5·35

I have appended the third column to enable comparison with Table I.

I was not without hope that a method for volumetrically estimating cobalt in presence of nickel might be based on these results. Between the peroxides of nickel and potassium iodide the products of the reaction are nickel protoxide and potassium iodate.

Accordingly the bromine-nickel-cobalt solution, after precipitation with calcium carbonate, was boiled to expel free bromine, and the ebullition continued after addition of potassium iodide. Results in Table V.

TABLE V.

Taken.	Co calc. from $Co_{13}O_{19}$.
1·89 Co + 1·89 Ni	2·11
0·75 Co + 3·79 Ni	0·90

Thus we find the not unexpected difficulty to the practical success of the method in the physical aggregation of the precipitate partly protecting the nickel peroxide from contact with the reducing liquid.

And this closes my practical work on the volumetric estimation of cobalt in presence of nickel. I question the likelihood of any satisfactory process being based on these higher oxides of cobalt. Their constitution is probably more complex than as usually symbolled, and to the formation of a number of intermediate compounds may be attributable the variations of the above experiments.

The product of the reducing action of hydrogen peroxide on manganese binoxide would appear to me to be a distinct oxide, and as also indicative of high molecular weight of manganese peroxide; and, doubtless, the same holds good of the higher oxides of nickel. These nickel oxides have of course come in for a passing examination during the investigation. The results are in harmony with those of another observer. I discharge a duty to Prof. Bayley in mentioning certain researches of his on the higher oxides of nickel and cobalt (CHEMICAL NEWS, vol. xxxix., p. 81). I regret having overlooked the work of this chemist until my own experiments were completed, otherwise I would have considered an examination of Fleischer's process superfluous. Prof. Bayley, by operating on cold solutions of nickel and cobalt with sodium hypochlorite, obtained compounds of the composition Ni_3O_5 and Co_3O_5. On warming the solutions they readily decomposed,—the former to the oxide Ni_3O_4, and even lower; the latter to $Co_{12}O_{19}$, and compounds intermediate between this and the sesquioxide.

Having operated entirely on boiling solutions, the nickel oxides obtained by me varied in composition from Ni_6O_7, when obtained by treating the nickel solution with bromine and excess of caustic soda, to Ni_3O_4, on precipitating the solution with excess of hypochlorite.

On the whole my paper is mainly corroborative of facts already pointed out by Prof. Bayley, and perhaps may be considered as slightly amplifying the same line of inquiry in noting the behaviour of cobalt peroxide in presence of free iodine and salts of hydriodic, hypochlorous, and hypobromous acids, and also hydrogen peroxide and ammonium hydrate; and its reduction to somewhat near the composition $Co_{13}O_{19}$.

Laboratory of Clyde Iron Works,
(By Tollcross) Glasgow.

A HOT BLAST OXYHYDROGEN FURNACE.

By H. N. WARREN, Research Analyst.

THE above-mentioned furnace was constructed by lining an ordinary injector furnace, about 2 inches thick, by means of a paste composed of slaked lime and baryta, allowing the casement to dry, and afterwards raising the heat to whiteness in order to obtain a uniform calcareous coating possessed of little fusibility. The hot blast was constructed by admitting the gases through separate spiral tubes, ½ an inch in diameter and 7 feet in length, the pipe through which the hydrogen or coal-gas was led con-

sisting of an ordinary iron gas-pipe, coated exteriorly with fused boracic acid to prevent oxidation; the oxygen pipe being composed of fire-clay, and both being surrounded by a thick iron casing, pierced with numerous draught-holes, and provided with a chimney to increase the draught, the construction of each being similar to an ordinary combustion furnace, the fuel consisting of furnace coke in admixture with charcoal to aid the combustion. The pipes were then raised to a bright red heat, the extremities of each being simultaneously connected to the furnace blowpipe, the oxygen tube replacing the air blast. The furnace was now urged to whiteness by means of an air blast, and a crucible—made by drilling well-burnt quicklime and chipping as thin as possible—was introduced into the furnace, and containing pieces of quartz. The gasometer containing the oxygen gas was now turned on; the flame from the furnace was immediately reduced to one-half its original size, but became of intense brilliancy, and during the lapse of five minutes had entirely liquefied the rock crystal. Alumina was melted so completely as to be unrecognisable from native corundum, and of the same hardness. Calcium phosphate, ferric oxide, clay, and sandstone were rendered sufficiently liquid to be poured from the crucible, while platinum was quickly volatilised. Chromium, tungsten, and metals of the earths were readily reduced, but, owing to the heat softening the crucible, could not be obtained homogeneous. The heat obtained from the furnace when properly regulated is fully equal to that of an electrical furnace.

A NEW APPARATUS FOR MEASURING GASES AND MAKING GAS ANALYSES.

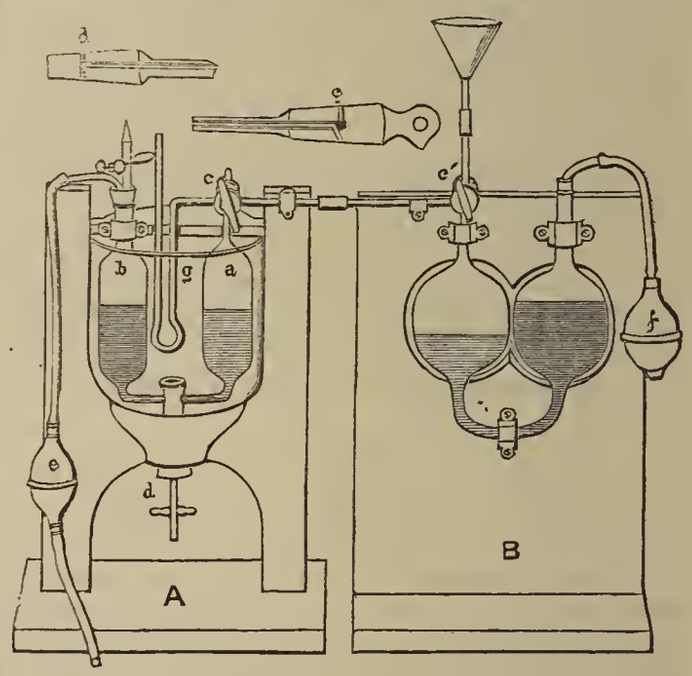
By E. H. KEISER.

In recent years the methods of gas analysis for industrial and technical purposes have been greatly simplified and improved, and are being used more and more extensively in manufacturing establishments. Much less progress has, however, been made in the more accurate scientific methods of gas analysis. While the labours of Orsat, Bunte, Winkler, and Hempel have resulted in bringing the methods of industrial gas analysis to such a condition of perfection that the composition of any gas mixture may be determined with great rapidity, and with a degree of accuracy sufficient for all manufacturing purposes, nevertheless, when more accurate results are required, recourse must be had to the older eudiometric methods of Bunsen. Admirable as these methods are, it cannot be denied that great skill is required to carry them out, and to obtain good results scrupulous attention must be given to all the minute details and precautions. The measurements being made in graduated eudiometers, it is necessary that the eudiometers should be calibrated, and tables of corrected readings constructed, before an analysis is made. There are inconveniences connected with the introduction and removal of absorbing reagents and as solid reagents are nearly always used, the absorption requires considerable time. In brief, the method is not at all adapted to making a series of rapid and yet accurate analyses.

Numerous forms of apparatus have been devised to overcome the difficulties of the Bunsen method. Among others, Regnault and Reiset,* Frankland and Ward,† Doyère,‡ and recently Hempel,§ have constructed instruments by means of which analyses can be made with as great accuracy as by the Bunsen method, and with much greater rapidity. Liquid instead of solid absorbing reagents are used, and the graduated measuring tubes are surrounded by water, so that an equality of temperature between the gas and water is rapidly obtained. All of these gas-measuring instruments are more or less complicated in construction. Graduated glass measuring tubes are used, thus necessitating a previous calibration. Most of them occupy a large space, and must be kept in separate rooms especially devoted to gas analysis.

It seemed therefore desirable to construct a simple gas-measuring apparatus which would be compact in form, which might be easily carried about and used at any place, and yet be capable of measuring gas volumes with great accuracy. Long graduated glass tubes and graduated vessels of all kinds were discarded, and an instrument was constructed upon the principle of determining the volume of a gas from the weight of mercury which it displaces at a known temperature and pressure. From the weight of mercury displaced the volume of the gas can be determined with much greater accuracy than by a direct reading on a graduated glass eudiometer.

The accompanying cut shows the construction of the measuring apparatus and the absorption pipette. A is the measuring apparatus, B is the absorption pipette; *a* and *b* are glass bulbs of about 150 cc. capacity. They are connected at the bottom by a glass tube of 1 m.m. bore, carrying the three-way stop-cock, *d*. The construction of



the key of the stop-cock is shown in the margin. One hole is drilled straight through the key, and by means of this the vessels *a* and *b* may be made to communicate. Another opening is drilled at right angles to the first, which communicates with an opening extending through the handle, but does not communicate with the first opening. By means of this, mercury contained in either *a* or *b* may be allowed to flow out through the handle, *d*, into a cup placed beneath. The bulb, *b*, is contracted at the top to an opening 20 m.m. in diameter. This is closed by a rubber stopper carrying a bent glass tube, to which is attached the rubber pump, *e*. To a second glass tube passing through the stopper, a short piece of rubber tubing with a pinch-cock is attached. By means of the pump, *e*, air may be forced into or withdrawn from *b*, as one or the other end of the pump is attached to the glass tube. The bulb *a* terminates at the top in a narrow glass tube, to which is fused the three-way stop-cock, *c*. The construction of the key of this stop-cock is also shown in the cut. By means of it the vessel *a* may be allowed to communicate with the outside air, or with the tube passing to the absorption pipette, or with the gauge *g*. The gauge *g* is a glass tube having a bore 1 m.m. in diameter and bent, as shown in the figure. By pouring a few drops of water into the open end of this tube a column

* Regnault and Reiset, *Ann Chim. Phys.* [3], xxvi., 333.
† Frankland, *Journ. Chem Soc.*, 1868, 109.
‡ Doyère, *Ann. Chim Phys*, [3], xxviii., 1.
§ Hempel, "Analyse der Gase," Braunschweig, 1880.

of water several centimetres high in both limbs of the tube is obtained. This serves as a manometer, and enables the operator to know when the pressure of the gas equals the atmospheric pressure. To secure a uniform temperature, the bulbs *a* and *b* are surrounded by water contained in a glass vessel. This vessel for holding water is merely an inverted bottle of clear glass from which the bottom has been removed. The handle of the stop-cock *d* passes through a rubber stopper in the neck of the bottle. A thermometer graduated to $\frac{1}{5}^{\circ}$ is placed in the water near the bulb *a*. The whole apparatus is supported upon a vertical wooden stand.

The absorption pipette B consists of two nearly spherical glass bulbs of about 300 c.c. capacity. They communicate at the bottom by means of a glass tube, 3 m.m. inside diameter. *c'* is a two-way stop-cock. The holes in the key are drilled at right angles, so that the tube which connects with the measuring apparatus may be put in communication either with the funnel or with the absorption bulb. The funnel is of service in removing air from the tube which connects the measuring apparatus with the absorption pipette. By pouring mercury or water into the funnel and turning the stop-cocks *c'* and *c* in the proper directions all the air is readily removed. *f* is a rubber pump used in transferring gas from B to A. The lower part of the pipette contains mercury, which protects the reagent from the action of the air.

To measure the volume of a gas the vessel *a* is filled completely with pure mercury. This is easily accomplished by pouring the mercury into *b*, and then, after turning *c* until *a* communicates with the outside air, forcing it into *a* by means of the pump *e*. Any excess of mercury in *b* is then allowed to flow out through the stop-cock *d*. When *a* and *b* are now placed in communication the the mercury will flow from *a* to *b*, and gas will be drawn in through the stop-cock *c*. The volume of mercury which flows into *b* is equal to the volume of gas drawn into *a*. When the mercury no longer rises in *b*, and it is desired to draw in still more gas into *a*, then it is only necessary to exhaust the air in *b* by means of the pump *e*. After the desired quantity of gas has been drawn into *a* the stop-cock *c* is closed. After standing a few minutes the temperature of the gas becomes the same as that of the water surrounding *a*. The pressure of the gas is then made approximately equal to atmospheric pressure, by allowing the mercury to flow out of *b* into a weighed beaker placed beneath the stop-cock *d* until it stands at nearly the same level in both *a* and *b*. Communication is now established between *a* and *g*, and by means of the pump *e* the pressure can be adjusted with the utmost delicacy until it is exactly equal to atmospheric pressure.

The stop-cock *d* is then closed, and the remainder of the mercury in *b* is allowed to flow out into the beaker. The weight of the mercury displaced by the gas divided by the specific gravity of mercury at the observed temperature gives the volume of the gas in cupric centimetres.

If it is desired to remove any constituent of the gas by absorption, a pipette, B, containing the appropriate reagent, is attached to the measuring apparatus. All the air in the connecting tube is expelled by pouring mercury into the funnel and turning the stop-cocks *c'* and *c* so that the mercury flows out through *c*. A little more than enough mercury to expel the gas in the vessel *a* is poured into *b*. The small quantity of air which is confined in the tube connecting *b* with the stop-cock is removed by allowing a few drops of mercury to run out through *b*. Then *a* and *b* are placed in communication. The stop-cocks *c* and *c'* are turned so that the gas may pass into the pipette, the mercury which filled the connecting tube passes into the absorbing reagent and unites with that which is already at the bottom of the pipette. The transfer is facilitated by the pump *e*. After absorption the residual volume is measured in the same way that the original volume was measured. *a* is completely filled with mercury from the upper to the lower stop-cock, and all the mercury in *b* is allowed to run out; the gas is then drawn back into the measuring apparatus, the last portion remaining in the connecting tube being displaced by means of mercury from the funnel. The volume is then determined as before.

The calculation of the results of an analysis is very simple. If the temperature and pressure remain the same during an analysis, as is frequently the case, then the weights of mercury obtained are in direct proportion to the gas volumes, and the percentage composition is at once obtained by a simple proportion.

If the temperature and pressure are different when the measurements are made, it is necessary to reduce the volumes to 0° and 760 m.m. The following formula is then used:—

$$V' = \frac{W(H-h)}{D\,(1 + 0{\cdot}00367 \times t)\,760},$$

in which

W = weight of mercury obtained (in grms.),
D = specific gravity of mercury at t°,
t = temperature at which the gas is measured,
H = height of the barometer,
h = tension of aqueous vapour,
V' = reduced gas volume (in cubic centimetres).

In all the measurements made with the apparatus the gas is saturated with aqueous vapour, because it comes in contact with the water in the manometer, *g*.

The following experiments were made to test the accuracy of the instrument. A quantity of air was drawn into the measuring bulb and its volume determined. The air was then transferred to an absorption pipette which contained only mercury and no reagent. It was then brought back again into the measuring apparatus and its volume re-determined. The following results were obtained:—

I.

	Volume at 0°—760 m.m.
Volume of air taken	57·558 c.c.
,, after first transfer	57·567
,, ,, second transfer ..	57·570

II.

	At 0°—760 m.m.
Volume taken	93·216 c.c.
,, after transferring	93 229

III.

	At 0°—760 m.m.
Volume taken	133·473 c.c.
,, after transferring	133·490

IV.

	At 0°—760 m.m.
Volume taken	92·275 c.c.
,, after transferring	92·260

V.

	At 0°—760 m.m.
Volume taken	109·025 c.c.
,, after transferring	109·020

VI.

	A 0°—760 m.m.
Volume taken	103·970 c.c.
,, after first transfer	103·955
,, ,, second transfer ..	103 980

The apparatus was also tested by making analyses of atmospheric air. It has been shown that the composition of the air varies from day to day.* This variation is sometimes as much as 0·5 per cent. The causes which produce these fluctuations in the composition of the atmosphere are at present but imperfectly understood. It is therefore desirable to have some simple instrument by means of which the composition of the air may be determined rapidly and yet with great accuracy.

* Winkler, "Industrie Gase," ii., 405. Hempel, *Berichte der deutsch. chem. Gesell.*, xviii., 267.

The following analyses show that the apparatus here described is well adapted to this purpose. The reagent used to absorb the oxygen and carbon dioxide was an alkaline solution of pyrogallol, prepared by mixing one volume of a 25 per cent solution of pyrogallol with six volumes of a 60 per cent solution of potassium hydroxide.

Analysis of Air taken from the Laboratory.

I.

	W.	H.	*t.*	V'.	Per cent $O+CO_2$.
Air taken ..	1738·53	743·37	15·8	116·435 cc.	—
Vol. of nitrogen	1377 62	743·37	15·8	92·264	20·760
,, ,,	1376·40	743·55	15·75	92·255	20·771

Per cent of oxygen and carbon dioxide, 20·765.

II.

	W.	H.	*t.*	V'.	Per cent $O+CO_2$.
Vol. of air ..	1708·01	748·08	15·0	115·546 c.c.	—
,, nitrogen	1356·04	747·33	15·2	91·564	20·755

Per cent of oxygen and carbon dioxide found, 22·755.

The following analyses were made with a sample of atmospheric air collected on a subsequent day:—

I.

	W.	H.	*t.*	V'.	Per cent $O+CO_2$.
Vol. of air ..	1704·81	754·92	12·2	117·814 c.c.	—
,, nitrogen	1348·33	754·78	12·08	93·216	20·877
,, ,,	1344·71	755·92	11·7	93·229	20·868

Per cent of oxygen and carbon dioxide, 20·872.

II.

	W.	H.	*t.*	V'.	Per cent $O+CO_2$.
Vol. of air ..	1669·39	756·30	10	116·584 c.c.	—
,, nitrogen	1323·24	755·49	10·05	92·260	20·863
,, ,,	1322·38	755·30	10·00	92·252	20·870

Per cent of oxygen and carbon dioxide, 20·866.

The apparatus described in the preceding pages was made for the author, in most excellent manner, by Mr. Emil Greiner, 79, Nassau Street, New York.—*American Chemical Journal*, Vol. viii., No. 1.

COMPOSITION OF STROMEYERITE.

By GEORGE A. KOENIG, Ph.D.

STROMEYERITE has been identified from Zacatecas, Mexico. At this locality the miners designate the various silver minerals by their colours, as black silver, red silver, green silver, and blue silver. Under the latter name—*plata azul*—several minerals are undoubtedly comprehended, but probably the most prevalent is the mineral here identified as Stromeyerite. One large specimen is composed of numerous prismatic crystals, the terminations broken off—resting on well-crystallised quartz, and from several smaller specimens it would appear that quartz is the ordinary associate of Stromeyerite at Zacatecas, while the other silver minerals—Proustite, Polybasite, Stephanite, Argentite—are more commonly associated with calcite. The faces of the crystals are rough, not admitting accurate measurements; the prismatic angle is near 120° to 119°. The mineral has no cleavage. Its fracture is uneven to flat subconchoidal, and very splintery. The lustre is brilliantly metallic and the colour iron-grey, with a strong bluish purple admixture. The colour of the powder is nearly the same. It is not sectile, but mild, and has a hardness of 3·5.

Sp. gr. = 6 2303, made upon 1·623 grms. of fragments from several crystals. Before the blowpipe it melts very readily to a globule, emitting sulphur dioxide, and changing to a grey globule of silver-copper. Gives no sublimate on charcoal, nor in open or closed tube, and dissolves in nitric acid, giving a blue solution, in which hydrochloric acid precipitates flocculent silver chloride.

A preliminary analysis made with a fragment from one crystal (0·2346 grm.) gave the result I.; a second analysis made upon the mixed fragments used in the determination of specific gravity (0·5 grm.) gave the result II.

I. $AgCl = 0·1615$; $Cu_2S = 0·0958$; $BaSO_4 = 0·2837$.
II. $AgCl = 0·2509$; $Cu_2S = 0·2105$; $BaSO_4 = 0·5758$.

From this we calculate—

	I.	II.
Insoluble	—	0·26
Ag	51·66	50·18
Cu	32·67	33·69
S	16·64	15·81
	100·97	99·94

Analysis II. having been made with twice the quantity of substance and with greater care, deserves alone to be taken as basis for the atomic ratio. Dividing the percentages by the atomic weights, we obtain—

Ag : Cu : S = 0·4661 : 0·9983 : 0·4975.
Ag + Cu : S = 0·5322 : 0·4975
= 2·007 : 1

Hence $47Ag_2S+53Cu_2S$.

It is seen that Ag and Cu are not exactly in the ratio 1 : 1, but very near. Undoubted Stromeyerite has been described heretofore only from two localities, Schlaugenberg, in Siberia, and Rudelstadt, in Silesia, and from the latter place only, in crystals. The analyses of the mineral from these places do not give the ratio of 1 : 1 for Ag and Cu either, but a little closer than the present locality of Zacatecas. Since Ag_2S and Cu_2S may replace each other isomorphically in all proportions without question, we may look upon such a ratio as Stromeyerite demands, 1 : 1, as quite an exception, owing, no doubt, to peculiar conditions present at the time of crystallisation.

The material for this investigation was obtained from Dr. A. E. Foote, who collected it during his recent visit to Zacatecas and other mineral localities in Mexico.—*Journal of Analytical Chemistry*, Vol. i., Part 1.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING JUNE 30TH, 1887.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To THE WATER EXAMINER, *Metropolis Water Act*, 1871.

London, July 5th, 1887.

SIR,—We submit herewith the results of our analyses of the 175 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from June 1st to June 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The condition of the water supplied to the Metropolis during the month of June did not differ substantially from that which has prevailed now for some months past; although, indeed, the proportion of organic matter present in the Thames-derived water, identical with that in the supply for April, slightly exceeded that met in the supply for the immediate preceding month of May. As for some months past, several samples of the East London Company's water were not wholly free from turbidity and consequent colour; but the proportion of organic matter present in this Company's water was exceedingly low, showing the turbidity to be entirely of a mineral and, apparently, an ochrey nature.

During the past six months we have examined 1057 samples of the water furnished to the Metropolis by the several companies taking their supply from the Thames and the Lea. In respect to the smallest of the proportion of organic matter present, the condition of the water has been throughout satisfactory. As regards freedom from turbidity, a failure in this particular was observable in several samples of Thames-derived water during the exceptional strain of a frost following a flood in the early part of January; and, as already mentioned, has been again noticeable recently in the East London Company's supply.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

NOTE ON STILLWELL'S METHOD OF OPIUM ANALYSIS.

By L. D. GODSHALL.

MR. C. M. STILLWELL (*Amer. Chem. Journ.*, viii., 295) has proposed a method for the analysis of opium, which is for the most part a modification of the method of Squibb. The chief novelty in the method consists in the use of saturated solutions of morphia for washing the crystals. My friend Mr. E. Luttgen, chemist for Keasbey and Mattison, has, at my suggestion, kindly compared this method with the one in use there (a modification of the method laid down in the U. S. P.) with the following results:—

Method of Keasbey and Mattison	(*a*)	9·95 per cent.
,, ,, ,,	(*b*)	10·00 ,,
Stillwell's method		10·05 ,,

Judging from this single comparison the method seems to be an accurate one. The only objection that suggests itself is that it is rather tedious. One point in connection with the method needs emphasis, viz., to conduct the evaporation in a shallow dish, as rapidly and at as low a temperature as possible, as otherwise morphia may be destroyed.—*Journal of Analytical Chemistry*, Vol. i., p. 23.

Manufacture of White Lead by means of Magnesium Acetate.—M. Kübel.—A strong solution of magnesium acetate rapidly transforms lead oxide into a soluble hydrate with an alkaline reaction. The precipitation of the lead in the state of carbonate is effected by means of carbonic acid so completely that the magnesium acetate may serve for a fresh operation. The proportions used are 1 part of magnesium acetate to 1½ of litharge; the acetate is made by acting upon magnesium carbonate with acetic acid at 7° Baumé; the liquid should contain 10 to 20 per cent of crystalline acetate.—*Dingler's Polyt. Journal.*

NOTICES OF BOOKS.

A. B. C. Five-figure Logarithms: or, Logarithms with Differences on a New and Simple Plan. By C. J. WOODWARD, B.Sc. London: Simpkin, Marshall, and Co.

Four-figure Mathematical Tables. By J. T. BOTTOMLEY, M.A., F.C.S., &c. London: Macmillan and Co. 1887.

NEXT to a good knowledge of figures naturally comes the best and most expeditious manner of using them, and there is certainly no better method of simplifying calculations of all kinds than that of using logarithms. Their use is now extending with great rapidity, and many students can now devote to actual work a great deal of time and thought which they were formerly compelled to give to working out results and tables of comparison.

Mr. Woodward's Table of Logarithms are arranged so as to be in the most easy form for reference, and they are provided with all necessary references and instructions for use, so that even those who are not very well up in the subject will be able to use them after a short study.

After the Table of Logarithms we come to a Table of Factors to facilitate calculations in quantitative analysis, with exercises and examples, so that the reader can become quite familiarised with their working.

These tables will appeal specially to chemists, by whom no doubt they will be greatly appreciated. The tables have been framed on the principle that they should be of as few figures as possible, and be found with the least trouble, and we must congratulate Mr. Woodward on having so successfully carried out the task he set himself.

We must also speak in terms of high commendation of Mr. J. T. Bottomley's "Four-figure Mathematical Tables." They comprise not only logarithms, but tables of anti-logarithms, natural sines, logarithmic sines, natural and logarithmic cosines, tangents, co-tangents, secants, &c., radian measure, squares, roots, and reciprocals. We have ourselves had a copy of the first edition of this book in constant use for several years past, and can therefore vouch for the very excellent quality and character it possesses: that it has been duly appreciated by those for whose use it was prepared is shown by the fact that a further issue has now been rendered necessary.

The School of Mines Quarterly, Columbia College. New York. 1887.

THE number of this Journal now before us contains several articles of great interest both to mining engineers and others. The first, on Sub-surface Water, describes the method adopted along the line of the Brooklyn aqueduct, increasing the supply for the city to 18,000,000 gallons daily from this source alone: 460 two-inch tubes were driven from 40 to 70 feet into the gravel, and the water running into them is pumped up. The idea is not claimed as new, but it has been found to be so thoroughly effective that it may be said that new resources—though not *always* available—have been opened to the engineer. In large towns, where the quantity of water required is very great, it will not do to rely on the surface supply. A good but varying proportion of the rain-water sinks into the ground, and finds its way back to the sea by underground channels. In the country, where the needs are not excessive, an excavation is made, and the sinking of the well is stopped when water is reached,—one reason being that the appliances available do not enable the farmer to sink far into the wet ground; but the driven well goes much deeper, and the tube can easily be driven to the depth required to get a good constant supply. The question of exploring or prospecting for underground water is an important one, and one which should be systematically studied, or otherwise a good deal of labour may be uselessly expended in driving a well where there is no water.

The article on "Drift Mining" describes the method employed for obtaining gold in certain parts of California where the auriferous gravel has been covered with the great lava overflows of the Pliocene period. The present streams have cut deep channels, first, through the lava deposits, then through the gravel beds, and finally into the hard slates underneath: it was this erosion by the water which caused the formation of the gold-bearing river-beds, so extensively worked in the early days of Californian mining. In places where the miners found the gold gravel-deposits on the hillsides, they were gradually led underneath the ground as far as they could go, and were then obliged to stop for want of proper appliances. These deposits are now being slowly developed, but it requires a more skilful miner to make the preliminary surveys than in any other kind of mining; however, when properly worked, this method of "drift mining" generally gives a good yield.

A paper follows on the "Action of Sulphurous Anhydride on Benzene." The authors have repeated some experiments made by Friedel and Crafts, who found that a mixture of benzene and aluminium chloride absorbs sulphurous anhydride with great energy, forming benzene-sulphuric acid. After several trials they succeeded in obtaining a dirty yellow crystalline substance, which, when dissolved in xylol and left, formed small transparent crystals belonging to the triclinic system, and melting at 70° or 71°. Portions of this substance were subjected to different treatment, and diphenyl sulphone (melting at 128°) and diphenyl sulphide (boiling at 272°) were obtained.

Agricultural Science. Vol. i., No. 5. Edited by C. S. PLUMB. Geneva, N.Y. 1887.

"AGRICULTURAL SCIENCE" is claimed to be the only Journal of its kind published in the English language dealing—as it does—with the purely scientific aspect of agricultural matters. No. 5 contains several articles: one by Sir J. B. Lawes, entitled "Some Remarks upon Foods"; one on the "Microbes of Nitrification"; "Researches on the Absorption of Ammonia by Clay," &c., followed by reviews of recent agricultural works and notes and abstracts of a variety of interesting matters of the same class.

Aids to Practical Chemistry. Especially arranged for the Analysis of Substances containing a Single Base and Acid Radicle. By J. HURD GORDON. London: Baillière, Tindal, and Cox.

THIS little book forms one of the "Students' Aid Series," which, as it is here said, are "specially designed to assist students in committing to memory and grouping the subjects upon which they are to be examined." The entire series appears to be especially arranged for persons whose object is to pass the primary examination of the Royal College of Physicians.

We are particularly struck with the definition of "radicles." Says the author, "By this term is understood bodies that are not saturated, and are therefore *unable to exist* until they have found something with which they are able to combine and thus become stable. These bodies are either elementary or compound. Chlorine, bromine, and sulphur afford examples of the former group." But experience certainly tells us that chlorine, bromine, and sulphur are perfectly able to exist uncombined. It is difficult to conceive how a body "unable to exist," or, in other words, non-existent, can seek and find something to combine with!

On page 9 we read a list of the ordinary colours of the salts of copper, iron, cobalt, nickel, and manganese, and are then told that "solutions of the commoner metals are generally colourless." Commoner than iron? Perhaps Mr. Hurd Gordon meant to say "solutions of the other common metals," or "solutions of the lighter metals."

The reactions given are those generally employed. We would, however, suggest that, in applying Marsh's test, the experimentalist should use only scraps of pure zinc or magnesium, as the zinc of commerce may contain arsenic enough to give indications of that element when not present in the body under examination.

A number of typographical errors might be advantageously corrected in case of a new edition. Thus, on page 10 we read of "Professor Olding's treatise," for Odling's; on p. 31 we find "silicates of soda of potash;" and on p. 33 "colourless gas ($CO+CO_2$) burns a mouth of test-tube."

A curious section is entitled "Examples of how to enter Results at Examinations." Here we find it stated that the non-occurrence of a precipitate with ammonia proves the "absence of members of Group II., also of oxalates and phosphates of Ba, *Sn*, and Ca." It is quite possible that a student may be here led astray.

The Retrospect of Medicine: being a Half-yearly Journal containing a Retrospective View of every Discovery and Practical Improvement in the Medical Sciences. Edited by JAMES BRAITHWAITE, M.D. Vol. xcv., January to June, 1887. London: Simpkin, Marshall, and Co.

WE find here an interesting account of poisoning due to inhaling the vapour of carbon disulphide. The symptoms closely resemble those of acute alcoholism. A certain proportion of workers in india-rubber are in a few months reduced to a lamentable condition of paralytic helplessness. Hence it is contended that such workshops should be placed under stringent regulations and be subject to the frequent visits of a Government Inspector.

In a note on the use of *Quillaja saponaria* in bronchitis we find mention of the remarkable power of this drug—Panama bark—in saponifying oils, which may explain some of its known uses in the arts, and suggest others.

To medical practitioners the "Retrospect" continues to present the same features which have for many years secured for it the all but universal patronage of the faculty.

CORRESPONDENCE.

DETERMINATION OF SULPHITES IN THE PRESENCE OF HYPOSULPHITES AND SULPHATES.

To the Editor of the Chemical News.

SIR,—We beg to call your attention to what seems to us an error in the article on the "Qualitative Determination of Sulphites in presence of Hyposulphites and Sulphates," in CHEMICAL NEWS, vol. lv., p. 242.

The author states that "if we treat a solution of an alkaline bisulphite with barium chloride there is formed neutral barium sulphite, and half the sulphurous acid remains in solution."

Having much to do with bisulphite solutions in connection with processes for making wood-pulp, we, some time ago, attempted to found a process for the estimation of actual bisulphite in a given solution upon the above-mentioned reaction, but without success.

We find that the sulphurous acid left in the solution is exactly one half of the total amount present as bisulphite in the original solution only in special cases, since, allowing a little time for the reactions to become complete, the amount of sulphurous acid in solution reduces to a constant quantity for a given temperature, viz., about 0·15 per cent at the ordinary temperature.

This holds true for magnesium as well as alkaline bisulphite solutions.

It appears to us also that the sulphurous acid remaining in solution exists, not as free acid, but in combination as barium bisulphite, and that its amount is dependent on the solubility of the latter in the menstruum, since, on heating the solution, SO_2 is given off, and we obtain a precipitate of neutral barium sulphite; and also from the fact that the solution (containing an excess of barium chloride) may be directly titrated with soda solution, using phenol-phthalein as indicator, with the same result as obtained from the titration with iodine; but with the simultaneous precipitation of neutral barium sulphite according to the following equation—

$$(BaSO_3,H_2SO_3) + BaCl_2 + Na_2O = 2BaSO_3 + 2NaCl + H_2O.$$

We have found, however, that if we treat a solution containing neutral and bisulphites together with sulphates, with an amount of neutral acetate of lead equivalent to the total amount of sulphur acids present, we have left in the solution free acetic acid equivalent to exactly one half of the sulphurous acid present as bisulphite in the original solution, and which may be titrated with alkali.—We are, &c.,

GRIFFIN AND LITTLE.

103, Milk Street, Boston, Mass.,
June 27, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. civ., No. 25, June 20, 1887.

Application of the Electrometer to the Study of Chemical Reactions.—E. Bouty.—The calculations which the author has presented in a former memoir (*Comptes Rendus*, civ., p. 283) solve, in principle, the problem of the application of the electrometer to the study of chemical reactions. Since we can calculate the conductivity, x, of a mixture where there is no chemical action, we have only to compare x with the conductivity, C, as measured. If there is even a slight difference it is the certain sign of a reaction, the intensity of which is approximately proportional to the difference $C - x$. The author takes, as an example, a mixture of potassium sulphate and sulphuric acid.

Researches on Certain Sulphites.—P. J. Hartog.—A thermo-chemical paper. The author shows that the double ammonium-magnesium sulphite is formed with a considerable liberation of heat, which supports the view of M. Berthelot of the existence of ammonium-magnesian bases, which combine with acids with a greater liberation of heat than the separate bases.

On the Potassium Manganites.—G. Rousseau.—The decomposition of potassium manganate by heat passes through a series of successive states, which are reproduced in an invariable order either in the absence or the presence of watery vapour. The thermic effect due to the combination of water with anhydrous potassa lowers the temperature corresponding to each of these states, and the continuous elimination of oxygen prevents the partial regeneration of the manganate and accelerates the progress of the phenomena.

Dissociation of Hydrated Oxalic Acid.—H. Lescœur.—The use of oxalic acid as a starting-point in alkalimetry was proposed by Mohr in 1852. Like many chemists he thought that this product, if exposed to the free air, contains always exactly 2 mols. of water. The author, and before him Erdmann, Winkler, Hampe, and others, have remarked that crystalline oxalic acid often contains more water than the theory allows. The use of anhydrous oxalic acid, proposed as more exact, is not practical. The author prefers to place the stock of crystalline oxalic acid under a bell over sulphuric acid at 53° B. At the ordinary temperature it does not effloresce, but merely loses excess of water, and presents then an absolutely constant composition.

Residues extracted from Steels and Zincs by Acids.—MM. Osmond and Weith.—If re-heated steel is attacked by dilute hydrochloric acid at the positive pole of a Bunsen element, there is isolated a skeleton formed of graphitoidal tablets, composed essentially of iron and carbon; but they contain, also, water in proportions varying with the conditions of the experiment, and generally an excess of oxygen. These residues, like those which have been studied by M. Debray, explode if dried in a hot air bath. Hence they have to be dried in a vacuum, and even then they are liable to spontaneous combustion.

Certain Reactions of the Vanadates and on their Use in Chemical Analysis.—Ad. Carnot.—The solubility of the alkaline vanadates renders them unfit for determination. Ammonium vanadate alone can serve for the determination of vanadic acid, by reason of its almost absolute insolubility in a liquid saturated with sal-ammoniac, and mixed with alcohol. But this reaction can serve only in very restricted cases; it requires very concentrated solutions, and is adapted neither to the separation of bases other than the alkalies, nor to that of acids, especially the phosphoric and arsenic. The determination of vanadic acid in presence of alkaline and ammoniacal salts may be effected much more easily in the state of barium vanadate under the following conditions. If the solution is acid it is saturated with ammonia as exactly as possible; it retains at first a yellow colour, but it is quickly decolourised on boiling. There is poured into it then a solution of barium chloride; it is stirred, and the white precipitate formed is allowed to settle. It is observed if fresh turbidity is produced by a further addition of this reagent, and that the ammoniacal odour is very slight. The flask is stoppered and let cool rapidly. All the vanadic acid is deposited as bibarium vanadate, which is received on a filter, washed with cold water, dried, and ignited. It is then of a white, slightly yellowish colour, and contains 37·372 per cent of vanadic acid. The filtrate does not retain any trace of vanadium. If, after the precipitation of the barium vanadate, it is boiled for some minutes, the precipitate attaches itself in great part to the sides of the flask. It becomes very difficult to collect and to weigh, but it can be thus very easily separated by decantation from the liquid, which may be turned to account, as it will be seen below. The salts of strontium do not give rise to the same reaction. If added to a vanadic solution, very slightly ammoniacal, but charged with sal-ammoniac, they produce no deposit either in cold or heat (if only the liquid contains no carbonate and is not left in contact with the air). The phosphates and arseniates, on the contrary, are precipitated by strontium salts under the same conditions. This difference of action may serve for separating *vanadic acid* from *phosphoric and arsenic acids*, which often accompany it in nature (vanadinite, descloizite, bauxite, iron ores, &c.). The same reaction may be used for the separation, at least approximately, of vanadic acid from molybdic and tungstic acids. The two latter are also precipitated on boiling as strontium salts in a slightly ammoniacal liquid, saturated with sal-ammoniac. But the precipitation is not rigorously complete. Lastly, a separation of baryta and strontia may be based upon the very distinct reaction just mentioned. We may proceed as follows:—The solution containing salts of barium and strontium is mixed with sal-ammoniac, and then saturated with pure ammonia free from carbonate. A dilute solution of ammonium carbonate is added and boiled for some

minutes. The precipitate of barium vanadate is formed at once in the state of heavy granules, which adhere to the glass. It is let cool with exclusion of air, decanted, and washed in cold water. In the liquid the strontia is precipitated by ammonia and ammonium carbonate, ignited, and weighed as strontium carbonate.

Transformation of Maleic and Fumaric Acids into Aspartic Acid by the Direct Fixation of Ammonia.—M. Engel.—Maleic and fumaric acid take up directly the elements of ammonia, and are thus converted into inactive aspartic acid. If the transformation is not total it is because aspartic acid is partially decomposed by water at 140° to 150°.

New Chloro-derivatives of Anisol.—L. Hugounenq.—The author has obtained several novel compounds, a dichloro-derivative, two trichloro- and two tetrachloro-compounds. All are permanent and volatile.

Archives Neerlandaises des Sciences Exactes et Naturelles.
Vol. xxi., Part 5.

Condition of Bodies after Arsenical Poisoning.—T. Zaaijer.—An occurrence, fortunately very rare, gave the author the opportunity of testing the opinion that the corpse of any person poisoned by arsenic undergoes a kind of mummification, and that such mummification is, to a certain degree, proof that death has been occasioned by arsenical poisoning. The wife of Johannes van der Linden was convicted, at Leyden, of having fatally poisoned four persons with arsenic. *Nineteen* other fatal cases were not judicially decided on, and, in addition, 36 persons had been rendered ill by arsenic administered by the same lady. The author, in conjunction with Dr. P. de Konig and Dr. E. A. van der Burg, was commissioned to examine the bodies of 16 of the victims, some of them two or three years after burial. His conclusions, which are of great importance for the toxicologist, are that:—The mummification of a corpse is a matter of very frequent occurrence. Check observations, made both by others and by the author, prove that bodies free from arsenic, if placed in the same conditions as bodies containing arsenic, resist putrefaction as well as the latter, and may also become mummified. The relatively frequent mummification of the sides of the abdomen and thorax, of the skin enclosing the joints of the wrist, the knee, and the ankle, and the skin of the fingers and toes, can easily be explained, independently of any influence of arsenic. The so-called "arsenical mummification" has no existence, especially for fatal doses. The mummification of a corpse has no value as a judicial proof of poisoning.

Journal für Praktische Chemie.
New Series, Vol. xxxv., Part 5.

Critique of the Foundations and Results of the so-called "Theory of the Formation-Heat of Organic Bodies.—J. W. Bruehl.—The author sums up by concluding that Prof. Thomsen's so-called theory of formation-heats is not suitable for investigating the atomic composition of bodies, and that any arguments drawn from it against Kekulé's benzol formula, or generally speaking for or against any view on the chemical constitution of organic bodies, are worthless.

Chemical Examination of the Schützenhof Spring at Wiesbaden. — H. Fresenius. — An exceedingly elaborate analysis of this mineral spring, more interesting medicinally than chemically.

The Formation of Indigo Blue from Ortho-nitro-phenyl-propiolic Acid by Means of Potassium Cyanide.—A. Michael.—If a solution of sodium ortho-nitro-phenyl-propiolate is heated with pure potassium cyanide and some glucose, there falls, in a short time, a precipitate of indigotine. The same reaction occurs if hydrocyanic acid is added to the above solution, even in large excess, and it is then heated to boiling. If the solution of the salt is heated with potassium cyanide without the addition of glucose, indigotine is not formed, but certain intermediate products.

On Allo-isomerism in the Crotonic Acid Series.—A. Michael and G. M. Browne.—The authors give a tabular view of the properties of the three known bromo-crotonic acid from which the isomerism of the new acid discovered by the authors appears.

A New Gas Burette.—B. Franke.—This memoir requires the accompanying diagram.

Action of Nitrous Acid upon Ortho-amido-benzamide.—A. Weddige and H. Finger.—On adding to the acid solution of 1 mol. ortho-amido-benzamide hydrochlorate or nitrate 1 mol. of sodium nitrite dissolved in water, a crystalline substance separates out in the form of yellow or brownish-yellow needles. It is readily soluble in hot water, from which it crystallises out in the form of pale rose-coloured needles. From a solution in benzol it separates out in shining leaflets. It fuses with decomposition at 213°. Its empirical formula is $C_7H_5N_3O$. The new substance is therefore an ortho-amido-benzamide, in which three atoms of hydrogen are replaced by an atom of nitrogen. It has acid properties; it dissolves readily in alkalies and ammonia, and is re-precipitated unchanged by acids.

Justus Liebig's Annalen der Chemie,
Vol. ccxxxviii., Part 3.

Researches on Gold (Second Treatise).—Gerhard Krüss.—The author here examines neutral and sublimed auric chloride and potassium-auric bromide, which exists in three modifications. He has determined the atomic weight of gold by five distinct methods, making, in all, 30 determinations, and arrives at the mean value 196·669. The mean numbers of sixteen experiments fell below 196·669, whilst fourteen showed a higher atomic weight. Two of the methods indicated higher atomic weights, whilst the three others pointed to a lower value, and in these three the difference between the maximum and the minimum result was the slightest. Hence Krüss proposes 196·64 as the atomic weight of gold. If we assume O = 16 the atomic weight of gold would be 197·13. With the figure 196·64 gold fits perfectly into the natural system of the elements.

On the Speed of Saponification.—L. Th. Reicher (Third Treatise).—This memoir does not admit of useful abstraction.

Acids formed from Levulic Acid after the Addition of Hydrocyanic Acid, γ-Methyl-hydroxylglutaric Acid, and Methyl-gluto-lactonic Acid.—J. Block, K. Kreckeler, and B. Tollens.—The main results of this investigation are:—Levulic acid, by the addition of hydrocyanic acid, yields a crystalline cyan-valero-lacton, $C_6H_7NO_2$, and this, if heated with hydrochloric acid, passes into a crystalline monobasic γ-methyl-gluto-lactonic acid, $C_6H_8O_4$, but if boiled with bases it forms salts of the bibasic γ-hydroxy-γ-methyl-glutaric acid, $C_6H_{10}O_5$. The latter acid, when set free, passes into the above-mentioned lactonic acid; γ-methyl-gluto-lactonic acid is re-converted into levulic acid if heated with sulphuric acid, carbon monoxide being given off. Besides cyan-valero-lactone there is formed a crystalline amide of γ-methyl-gluto-lactonic acid.

Certain Salts of Levulic Acid.—Dr. J. Block and B. Tollens.—A description of the barium and strontium salts. The magnesium salt has been obtained only as a gummy mass.

Origin of Galactose and Levulose from Raffinose.—J. Haedicke and B. Tollens.—The authors infer from their observations that the inversion products of raffinose yield mannite and dulcite on hydrogenisation, which confirms their result that raffinose, on inversion, yields

galactose and levulose. The former of these compounds yields dulcite and the latter mannite on treatment with sodium amalgam.

On Galactose from Carragheen Moss.—J. Haedicke, R. W. Bauer, and B. Tollens.—The group yielding mucic acid, which appears as galactose on heating with sulphuric acid, is plentifully found in Carragheen moss.

Communications from the Chemical Laboratory of the University of Geneva.—These communications include papers by C. Graebe, on tetra-chlor-phthalic acid; by G. Kircher, on tetra-chlor-ortho-benzoyl-benzoic acid; by A. Le Royer, on β dichlorphthalic acid; and by C. Graebe, on the boiling-points of diphenylamine and of its homologues.

A Preparation of Para-dinitro-dibenzyl.—W. Roser.—This compound is obtained by reducing para-nitro-benzyl chloride with a strongly alkaline solution of stannous chloride.

The Tannin of Oak-wood.—Dr. Carl Böttinger.—The tannic acid of oak-wood seems to have the composition of a digallic methyl-ether. Its constitution must differ essentially from that of true tannin, as appears from its behaviour with bromine and alkalies.

Vol. ccxxxix., Part 1.

On the Terpenes and the Ethereal Oils. — O. Wallach.—The following terpenes can now be clearly distinguished :—Pinine, camphene, limonene, dipentene, terpinoline, sylvestrine, terpinene, and phellandrene.

Communications from the Chemical Laboratory of the University of Geneva.—These include researches by A. Bonna, on phenyl-paratoluidine; by N. Dobreff, on orthodibenzyl-dicarbonic acid; by S. Racine, on certain derivatives of orthotoluylic acid; and, by the same author, on phthalaldehydic acid.

On New Compounds of Benzyl and Benzoyl.—C. A. Bischoff and H. Siebert.—This memoir does not admit of useful abstraction.

Action of Iodine upon the Derivatives of Sodium Malonic Ester.—C. A. Bischoff and A. Hausdoerfer.—This paper also is not adapted for abridgment.

MISCELLANEOUS.

Coal Tar and Ammonia.—Messrs. Gurney and Jackson will shortly publish Professor Lunge's "Coal Tar and Ammonia," being a new and very much enlarged edition of the author's "Distillation of Coal Tar," published by Mr. Van Voorst in 1882.

Messrs. F. Sartorius, of Göttingen, have just issued a new price list of the chemical and physical apparatus made by them. They make a large number of chemical and other balances; and their patent short-armed balances, with all recent improvements, are excellent instruments, and can be had at a very reasonable price.

City and Guilds of London Institute.—On Friday last, July 15th, the Students at the Technical College, Finsbury, gave their third *Conversazione*. Popular Lectures were delivered by Prof. W. E. Ayrton, F.R.S., and Prof. Meldola, F.R.S. There were, in addition to these lectures, numerous other attractions, including two concerts, which could be heard either in the Concert Hall or by telephone in another room, and a great variety of machinery and apparatus used in the College, together with models and machines actually made by the Students. We must not omit to mention the chemical exhibits lent by Messrs. Boake and Co., Townson and Mercer, Hopkin and Williams, and many others. Messrs. Beck and Co., Crouch, Cetti, and Maignen were also represented here, the first-named firm showing, besides a score or more of microscopes, the grinding of lenses. Dr. Curtius, of Erlangen, sent a sample (the first seen in England) of his latest discovery, hydrazine sulphate; and a large number of coal-tar products were laid out for inspection. The electrical department, however, yielded the palm to none for the number and beauty of their exhibits, which we have no space to detail. We must heartily thank the Students for their splendid entertainment, and congratulate Professors Thompson, Perry, and Meldola on having such energetic students under them.

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NOTES ON THE GROUP OF RARE EARTHS, CONSIDERED *A PROPOS* OF MR. CROOKES'S THEORY OF THE GENESIS OF ELEMENTS.

In Vol. xvii., No 5, of the *Archives des Sciences Physiques et Naturelles* there is a long article by M. de Marignac on the Group of Rare Earths in which he discusses and criticises my recent lecture delivered at the Royal Institution on the "Genesis of the Elements. Everything that M. de Marignac writes, especially on the subject of the rare earths, upon which he has worked so long and so successfully, is deserving of the most respectful attention, and I certainly should not have ventured to criticise any remarks which he might make on my own researches had he not admitted in this paper that he may have imperfectly understood my arguments owing to want of familiarity with the English language. In some few particulars he has mistaken my meaning, and I therefore take the opportunity in reviewing this article of pointing out what these mistakes are and where they occur. After briefly commenting on the first part of the lecture he goes on to say that "Mr. Crookes admits the existence, at the beginning of time, of a primordial matter uniformly distributed throughout space, which he proposes to call protyle. It was not then matter as we now know it, in one of its solid, liquid, or gaseous forms, for it was still uncondensed into atoms; it was probably in that ultra-gaseous state which he calls 'radiant matter,' to which he assigns those particular properties which can be observed in bulbs wherein the gas has been reduced to a pressure of less than one-millionth of an atmosphere."

In this conjecture M. de Marignac has not exactly caught my meaning. "Radiant matter" is highly rarefied gaseous matter acting under the influence of the electric discharge in a high vacuum. "Protyle" is the name given to that hypothetical substance, so to speak, which existed before matter as we now know it was formed, and from which it is conjectured atoms were made.

The next point of interest is connected with this theory of the formation and possible difference in the weight of atoms of the same elements. It runs as follows:—

"I will mention one point of this theory, and that is, that, according to the manner of formation admitted by the author, he considers it possible that the atoms of any particular element may not be all of exactly the same weight, and that when we say, for example, that the atomic weight of calcium is 40, it is possible that it is formed principally of atoms weighing 40, and to a small degree of atoms of 39·9 and of 40·1, and in a still smaller degree of atoms weighing 39·8 and 40·2, &c. One can conceive more easily in this hypothesis, that by very delicate chemical means we might succeed in separating a body reputed simple into several distinct but almost identical bodies.

"I have still less the intention of criticising Mr. Crookes's theory. I have always admitted* the impossibility of accounting for the curious relations which are manifested between the atomic weights of the elements, except by the hypothesis of a general method of formation, according to definite though unknown laws; even when these relations have not the character of general and absolute laws. I am, therefore, in perfect agreement with Mr. Crookes on the basis on which the question rests. As to the details of his theory, I have no means of disputing them, since they all rest on hypotheses whose experimental demonstration is, and for a long time will be, impossible.

"But among the arguments brought forward by Mr. Crookes in support of his opinion, there is one which depends on the consideration of facts about which there should certainly be some reserve, if only to prevent their concordance with a theory, without doubt very hypothetical, as the author himself admits, but still possessed of a great degree of probability, contributing to confirm in it an appearance of certainty which does not appear to me to be sufficiently established."

After mentioning the method of fractionation employed in the separation of the rare earths, M. Marignac goes on to say:—

"As for the chemical properties of these new earths, Mr. Crookes does not think there can be any other difference between them beyond a more or less pronounced basic energy, which permits their gradual separation by means of fractional precipitation by ammonia. He admits, although without bringing forward any evidence to prove it, that they are all of the same atomic weight. But the most remarkable fact is the absolute identity of all their spectra, when examined by the ordinary methods of spectrum analysis, such as by submitting a solution of the chlorides to a strong electric discharge."

I must here remind my readers that I have not yet admitted the identity of these atomic weights, and further that it is by no means established that the spectra referred to are identical.

M. de Marignac next proceeds to the consideration of two theories which I considered possible explanations of the facts observed, and suggests the possibility of a third hypothesis. "If I now bring one forward," he says, "it is not because I attribute to it a greater degree of probability than that possessed by the two preceding ones. Far from it. But I do not see that the facts stated by Mr. Crookes suffice to reject it as inadmissible, and I regret that he himself has not mentioned it, even to show its failings, nobody being better able than himself to show if it is or is not in agreement with the numerous experiments that he has made during the past few years.

"Perhaps, in collecting all the proofs for this refutation, he might have been led to try new experiments, which would have removed all doubts.

"Mr. Crookes has shown that an earth* which, by itself when pure, viz., oxide of samarium, gives but a feeble phosphorescent spectrum, produces a much more brilliant one when mixed with lime, and that this spectrum is still evident when the proportion of this earth in the lime is reduced to one millionth, and even less."

M. de Marignac then goes on to say—"It is true that this method, so delicate in certain cases for recognising the presence of a body in a mixture, is, at the same time, so capricious, that when this same oxide of samarium is mixed with yttria it in no way changes the spectrum of this latter earth so long as its proportion in the mixture does not exceed 35 per cent; on the other hand, the spectrum of yttria disappears, and leaves nothing but that of samaria when the proportion of samaria exceeds 43 per cent. Could we not then suppose that the fractional precipitations to which yttria has been submitted have only effected the accumulation at the two extremities and in some of the intermediate places, some imponderable traces of other metallic oxides, whose presence cannot be proved by chemical analysis, and whose nature would be more difficult to recognise, inasmuch as it might be their presence in yttria which conferred upon that body the property of emitting phosphorescence."

In reference to the theory which M. de Marignac advances, I at once admit that it is most reasonable, and one which may probably explain many of these obscure phenomena. A similar explanation occurred to me some time ago, and it is identical with one I published in

* "See for example the remarks I made in 1860 and 1865, after the publication of M. Stas's researches on atomic weights (*Archives*, ix., 102; and xxiv., 376)."

* *Comptes Rendus de l'Académie des Sciences*, vol. c., p. 1495.

January last* as one of the possible explanations of the variation in the spectra of another earth which I was submitting to fractionation.

In speaking of the similarity of the spectra of Yα, and a mixture of 61 parts of yttria and 39 parts of samaria M. de Marignac says:—

"My first impression was that Mr. Crookes meant that my earth was really nothing more than a mixture of yttria and samaria. Now, such an opinion on my part is untenable in presence of the facility with which one can succeed, if not exactly, in separating these two earths one from the other, at least in proving their existence, by precipitating their solution by sulphate of potassium; yttria is, in fact, soluble in thirty times its weight of a saturated solution of the salt, while samaria requires about 1000 parts.

"But how can I attribute this opinion to the learned chemist who has expressed himself in so precise a manner on the necessity of controlling, by rigorous chemical means, the results which spectroscopy has indicated.† Still less can I do so, since Mr. Crookes knows better than anybody the characteristic properties of gadolinia, having stated, as he has, that in samarskite he came across an earth, identical in its chemical and spectroscopic properties with the one which I discovered."‡

M. de Marignac is not quite accurate here. The point I wished to insist upon was that the spectrum of the mixture gave the Yα spectrum together with the very brilliant line of Gδ. The earth Yα, both of M. de Marignac's and of my own preparation, gave a spectrum free from the Gδ line, but consisting of other lines which occur in the spectra of yttrium and samarium. I thereupon said, if it were possible to remove Gδ from this mixture, I should leave Yα behind. I did not exactly "come across" an earth in samarskite similar to Yα, but obtained it by submitting the yttria earths (roughly purified) from that mineral to a most severe course of fractionation.

M. de Marignac then dwells at some length on the question of the atomic weights of yttrium, and quotes several analyses and estimations made by M. Nordenskiöld in which the atomic weight varies between such wide limits as 238·7 and 312·0, after which he concludes—

"If we notice that the earths which accompany yttria have molecular weights generally much higher than it has, and not differing much from each other (ytterbia, 392; erbia, 380; Yα, about 362), I believe that all we can be sure of is that this earth is always met with in nature mixed with a variable number of other analogous and isomorphous earths, of a much higher molecular weight, and generally preponderating in the mixture.

"Mr. Crookes is therefore not justified in saying that we have proof of the existence in nature of a mixture of isomorphous bodies always associated together, and having an atomic weight as constant as if they constituted a simple body.§

"I do not the less acknowledge that the fact of constant association of these elements is one of the strongest proofs that can be found of the community of the origin. Besides it is not an isolated fact; we can find other examples, such as the habitual association in minerals of tantalum, niobium, and titanium."

A Carbohydrate contained in Acorns. — MM. Camille Vincent and Delachanal.—The compound in question, to which the authors propose to give the name quercine, is a hexatomic alcohol, isomeric with inosite, from which it differs by its crystallisation, by its melting-point, which is 342°, in place of 217° (inosite); by the higher melting-point of its hexacetyl derivative, and by its much slighter solubility in water.—*Comp. Rend.*, No. 26.

* *Proc. R. S.*, vol xlii., p. 26, and CHEMICAL NEWS, vol. lv., p. 25.
† *Comptes Rendus de l'Académie des Sciences*, vol. c., p. 1497.
‡ *Ibid.*, cii., p. 646.
§ These were Professor Nordenskiold's words, not mine.—W.C.

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT.
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THIS plant is well known in the West as the "soap-weed." It grows very abundantly in most of the Western States and Territories. It has attracted the attention of botanists, and it is a plant of interest on account of the many uses to which it has been put in the countries where it is found.

The results noted in this paper are based upon a first and introductory chemical analysis of the *Yucca*. Previously, little has been studied of its chemistry. It is briefly mentioned in the work of a French writer, Dr. Georges Pennetier†; also in a paper on the study of manganese found in the ash of plants, in which M. Maumené states that the ash of the *Yucca* contains manganese.‡ He does not name what species of *Yucca* was examined. The former writer gives the micro-chemical characters of the action of iodine and sulphuric acid, dilute chromic acid, and cuprammonia on the fibres of the *Yucca angustifolia*.

The specimens of *Yucca* used in these analyses were of large growth and in good condition. The entire plant was examined, and a separate study made of the bark and wood of the root, and of the green leaf and the yellow basal part. The roots were air-dried, freed from adherent dust, reduced to a very fine powder, and passed through a No. 80 sieve. The leaves were less finely powdered.

Dragendorff's scheme for plant analysis§ has been generally followed. 10 grms. of the air-dried powder were used for the preliminary examination of soluble substances. For every grm. of the powder 10 c.c. of the solvents were employed. An additional quantity of the powder was prepared for special purposes. 5 grms. of the air-dried powder were dried in a hot-air oven at a temperature between 100° C. and 110° C. until the weight remained constant, for the estimation of moisture. This powder was incinerated in a covered porcelain crucible at a dull red heat until the carbon was entirely consumed. The per cent of total ash was determined from it.

QUALITATIVE ASH ANALYSES.

Calcium, magnesium, potassium, sodium, iron, manganese, chlorides, phosphates, and sulphates were found in every part of the plant.

Determination of { I. *Moisture* / II. *Total Ash* } *on the Powder.*

	I.	II.	Colour of Ash
(1). The bark of the root	6·78 p.c.	17·38 p.c.	Reddish.
(2). The wood of the root	11·67	15·75	,, grey.
(3). The green leaf .	8·11	5·75	Grey.
(4). ,, yellow base of leaf	37·00	10·63	White.

PETROLEUM SPIRIT EXTRACTS.

Extract (1) *Bark of Root.*

The maceration was conducted in an apparatus similar to one described in Dragendorff's "Plant Analysis."‖ A light petroleum spirit was used, which boiled between

* Reprinted from the *Transactions of the American Philosophical Society*.
† "Lecons sur les Matières Premièr s Organiques," Paris, 1881 p. 446
‡ M. E. J. Maumené, *Bull de la Société Chimique de Paris*, Tome xlii., p. 305.
§ "Plant Analysis: Qualitative and Quantitative," by G. Dragendorff. Translated from the German by Henry Greenish, London 1884.
‖ P. 99. Tollen's apparatus.

25° C. and 45° C. The *extract* was filtered from the powder-residue. It was a clear pale yellow-coloured liquid, and slightly acid in reaction. A drop of the *extract*, on evaporating, left a uniform spot on blue paper. The *extract* was evaporated at the ordinary temperature. The *residue* was a solid, and it had the odour and characteristic crystalline structure of fatty acids, suggesting the presence of a fixed oil. Its melting-point was taken. The substance melted at 60° C., and, on cooling, solidified amorphous. To determine the total amount of solids extracted, a definite volume of the *extract* was evaporated, dried, and weighed.

Total Solids.

	Per cent.
Petroleum spirit residue dried at 100° C. ..	1·24 of solids.
,, ,, ,, 110° C. ..	1·20 ,,
	0·04 of loss.

The *residue* was identified as a fixed oil. It was soluble in petroleum spirit, ether, benzol, chloroform, amyl alcohol, carbon disulphide, and cold aqueous alkalies; incompletely soluble in cold or boiling 86 per cent alcohol, 95 per cent alcohol, absolute alcohol, acetic ether, and ammonium hydrate. No change of colour was observed on treating the fixed oil with concentrated sulphuric acid, nor on the addition of syrupy phosphoric acid, though it was partially soluble in these acids. Phosphoric acid coloured it yellow; it was coloured yellowish by concentrated hydrochloric acid and nitric acid of 1·22 sp. gr. A mixture of concentrated sulphuric acid and nitric acid of 1·22 sp. gr. changed the colour of the fixed oil to a reddish brown; it was coloured pale green by sulphuric acid of 1 634 sp. gr. and of 1·53 sp. gr. Calcium disulphide gave a bright green colour reaction with the fixed oil, but did not form an emulsion with it; aqueous solutions of gold and platinum chlorides were reduced by it. The fixed oil was saponified with difficulty by alcoholic soda, but readily by boiling aqueous soda; a white fragile soap was separated and filtered from the liquid. The soap was decomposed by hydrochloric acid and the fatty acids separated. The filtrate from the soap was examined for glycerin. By the method* used an oily liquid was obtained; it was heated with anhydrous borax on platinum foil, and gave the usual green-coloured flame test for glycerin. The alcoholic solution of the *petroleum spirit residue* was fractionally precipitated with an alcoholic solution of magnesium acetate, and traces of an amorphous residue were recovered.†

The *petroleum spirit residue* was digested with water containing sulphuric acid, and examined for alkaloids, which are sometimes brought down with fixed oils. The usual reagents failed to detect traces of alkaloids.

Extract (2), *Wood of the Root.*

The maceration was carried out under the same conditions as in *extract* (1).

The *extract* was a clear colourless solution, neutral in reaction. A drop of the liquid left no uniform spot on blue paper. The *extract* was evaporated at the ordinary temperature. The *residue* was light yellow-coloured, of a semi-solid consistency, and melted at 36° C. A definite volume of the *extract* was evaporated, dried, and weighed.

Total Solids.

	Per cent.
Petroleum spirit residue dried at 100° C. ..	0·55 of solids.
,, ,, ,, 110° C. ..	0·35 ,,
	0·20 of loss.

The *residue* was identified as a fixed oil, associated with volatile fatty acids. The latter were indicated by the 0·2 per cent of loss and the disagreeable odour of the *residue*, which was dissipated on heating at 110° C.

The *petroleum spirit residue* from the *extract* was evaporated at the ordinary temperature, dissolved with difficulty in cold 95 per cent alcohol, and in boiling weaker alcohol; absolute alcohol hardened and discoloured it. Concentrated sulphuric acid, nitric acid, and hydrochloric acid did not appreciably act on the *residue*. It was not saponified, but slowly dissolved by boiling aqueous and alcoholic soda. The alcoholic solution of the *petroleum spirit residue* was submitted to a fractional precipitation with an alcoholic solution of magnesium acetate. The first precipitation obtained was purified by boiling alcohol; it was an opaque scaly crystalline solid which melted at 85° C. The second precipitation yielded traces of a white amorphous substance. The third precipitation resulted from adding strong ammonia water to the magnesium acetate solution, and the purified residue melted at 60° C.

Negative tests for alkaloids followed an examination of the aqueous treatment of the *petroleum spirit residue*.

Extract (3), *Green Part of the Leaf.*

The method of extraction was the same as that used in the previous extractions. The *extract* was clear pale green in colour and non-fluorescent. It was coloured by a small quantity of chlorophyll, which the petroleum spirit dissolved. The liquid was acid in reaction. A drop of it left a permanent stain on blue paper when evaporating. The *extract* was evaporated at the ordinary temperature and the *residue* was a dark greenish yellow semi-fluid substance. The solidifying point was taken. It was found to be about 15° C. A definite volume of the *petroleum spirit extract* was evaporated, dried, and weighed.

Total Solids.

	Per cent.
Petroleum spirit residue dried at 100° C. ..	2·20 of solids.
,, ,, ,, 110° C. ..	2·01 ,,
	0·19 of loss.

The *petroleum spirit residue* was identified as a fixed oil with a small amount of chlorophyll that had been brought into solution by it. It was soluble in cold 83 per cent alcohol, 95 per cent alcohol, absolute alcohol, amyl alcohol, ether, acetic ether, chloroform, benzol, carbon disulphide, and glycerin. It was also soluble in oil of turpentine, almond oil, ammonium hydrate, mercuric chloride, and slowly soluble in acetic acid. Concentrated nitric acid and hydrochloric acid slowly dissolved the fixed oil, the former coloured it dark green, and on stirring the mixture the colour was changed to a brown. Concentrated sulphuric acid dissolved and changed it to a very dark brown colour; on adding concentrated nitric acid the liquid was changed to a reddish brown colour.

The following reactions were noted:—The fixed oil changed to a hard greenish yellow substance on heating it with anhydrous borax on platinum foil. When rubbed on a crucible lid with powdered rosan line it was coloured red, showing the presence of free fatty acids. It did not emulsify with calcium disulphide or with syrupy antimony chloride, but it was coloured dark green by the latter. It was imperfectly dissolved by phosphoric acid, and slowly soluble in equal parts of cane-sugar and concentrated hydrochloric acid; more rapidly soluble in equal parts of cane-sugar and nitric acid. An aqueous solution of picric acid made alkaline by sodium carbonate coloured the fixed oil a light reddish brown colour, cane-sugar added to the solution facilitated dissolving it. It was instantly dissolved by equal parts of picric aid and acid ammonium phosphate, and on warming with stannous chloride, leaving a turbid yellow-coloured liquid. It was insoluble in aqueous barium hydrate; soluble in alcoholic ammonia with no colouration, and in sulphurous acid. It was coloured brown when mixed with sulphuric acid of 1·634 specific gravity, and incompletely dissolved; it was also coloured brown by ferric chloride. On adding to the fixed oil sulphuric acid of 1·475 sp. gr.

* "Plant Analysis," G. Dragendorff p. 12.
† *Loc. cit.*, p. 16

and a small quantity of zinc, hydrogen was generated, and the solubility of the oil in the acid liquid was accompanied by a rosy tint given to the solution.

Extract (4), *Yellow Part of the Leaf.*

This *extract* was obtained by a similar process as that used for the other petroleum spirit *extracts*. The *extract* was a pale yellow-coloured liquid. The reaction was slightly acid. A uniform spot was left on blue paper as the drop evaporated. The petroleum spirit was evaporated at the ordinary temperature, and a yellow-coloured *residue* recovered, of a semi-solid consistency and crystalline in structure. It solidified at 12° C. From a definite volume of the *petroleum spirit extract* the amount of total solids was determined.

Total Solids.

	Per cent.
Petroleum spirit residue dried at 100° C. ..	1·1 of solids.
„ „ „ 110° C. ..	1·1 „
	0·00 of loss.

The *residue* was identified as a fixed oil. It was soluble in warm absolute alcohol, incompletely soluble in weaker alcohol; soluble in cold acetic ether, chloroform, benzol, amyl alcohol, ether, carbon disulphide, and glycerin. It was saponified with aqueous soda, and a white soap separated. No reaction was observed with picric acid and ammonium phosphate, nor with nitric acid of 1·32 sp. gr. and 1·18 sp. gr. The fixed oil was soluble in potassio-mercuric iodide solution, and coloured dark brown by alcoholic ammonia. A mixture of ferric chloride solution and powdered rosaniline gave a fine violet-coloured reaction with the fixed oil.

An examination of the aqueous treatment of the *petroleum spirit residues* (3) and (4) for alkaloids gave negative results. A portion of the original powder, from each of the four parts of the plant, was mixed with an aqueous solution of caustic soda, and the distillate examined for volatile alkaloids, with negative results.

(To be continued).

STUDY ON THE REACTIONS OF THE VANADATES FROM AN ANALYTICAL POINT OF VIEW.

By AD. CARNOT.

The author completes in this note his examinations of the reactions produced between the vanadates and the chief metallic salts in the ordinary conditions of analysis.

If we pour ammonia gradually into a cold acid solution containing vanadic acid, the liquid takes a more and more decided yellow colour up to the moment when it takes an alkaline reaction. This colour persists for some time if the solution remains cold. If we proceed inversely, and add acid by degrees to a colourless alkaline solution of vanadium, at the moment when it begins to redden litmus, the yellow colouration appears in full intensity, and becomes weaker on adding an excess of acid. There seems to be formed in a solution nearly neutral an acid ammonium vanadate of more colouring power than the free acid. At this moment the reactions produced by metallic salts are often different from those observed in presence of neutral vanadates. There are formed acid vanadates coloured differently from the neutral salts. To obtain the latter we may set out from an ammoniacal solution, and saturate it gradually and incompletely with an acid; or, better, operate in heat, because then the slightest excess of ammonia is sufficient to bring back the acid ammonium vanadate to the state of a neutral salt. It is advisable to determine vanadic acid by the salts of barium, manganese, or uranium, at a boil. On operating in the cold, and saturating the acid solution gradually with ammonia, we obtain with barium a yellow and less basic precipitate, whilst it is white in hot liquids. Other metallic salts present analogous instances.

Salts of Cobalt and Nickel.—A nitric solution of cobalt and of vanadic acid, exactly neutralised with ammonia in the cold so as to remain deeply yellow, soon becomes turbid, and then gives an orange-yellow deposit. The precipitation of the cobalt may become complete in the course of some hours, especially if the excess of ammonia is entirely saturated with acetic acid. The reaction is slower and more difficult if the liquid contains an ammoniacal salt other than the nitrate.

Nickel gives an analogous precipitate less readily; the precipitation is hindered by a few grammes of ammonium nitrate In heat we obtain a pale yellow precipitate with nickel, and a brownish yellow with cobalt, but always incomplete; the presence of ammonium chloride may even prevent the appearance of any turbidity.

Salts of Zinc.—If we saturate exactly with ammonia a cold acid solution of zinc and of vanadic acid, we obtain a yellow precipitate. On heating the liquid the deposit turns white. It is very bulky, and consists of the vanadate and of other salts of zinc. There is also a white precipitate formed in the cold on mixing the neutral solution of a zinc salt with neutral colourless ammonium vanadate. It is very easily soluble in acids or in ammonia, but, on driving off by ebullition all the excess of ammonia, we obtain all the vanadic acid precipitated with an excess. We find that no vanadium remains in the decanted or filtered liquid by adding ammonium hydrosulphate, which ought to produce merely a white precipitate of zinc sulphide. Very small quantities of vanadium would colour the liquid brown and the precipitate *rose*, sometimes very bright. This rose-colour, which is permanent after washing the zinc sulphide with sulphuretted hydrogen water or pure water, seems to indicate that it is really combined with vanadium sulphide.

Salts of Cadmium.—There is formed a white precipitate in a neutral liquid; the least excess of acid or of ammonia prevents its production: it is almost always incomplete, even after prolonged boiling in presence of ammoniacal salts. Ammonium hydrosulphate yields yellow cadmium sulphide and a brown solution of sulphovanadate.

Salts of Copper.—On saturating gradually with ammonia a solution of vanadic acid and of a copper salt, there is produced in the cold a greenish yellow precipitate, which becomes a greenish brown on ignition. In heat there is formed a brownish yellow deposit, which becomes black on ignition. In both cases the precipitation of vanadium is incomplete. In presence of the same salts ammonium hydrosulphate produces a black deposit and a clear brown supernatant solution. But the deposit of copper sulphide retains a very appreciable proportion of vanadium sulphide, and the liquid contains dissolved copper. Hydrochloric acid produces in it a deposit of double sulphide of a very light rose-brown colour. It must be noted that, under the same conditions, a solution of arsenic acid and of a salt of copper, treated with ammonium hydrosulphate, yields, with the deposit of copper sulphide, a clear slightly brownish solution, which, if decomposed by hydrochloric acid, yields a yellowish orange deposit, very analogous in appearance to antimony sulphide, and consisting of copper sulpharseniate.

Mercurous Salts.—Vanadic acid may be precipitated from a nitric solution, almost exactly neutralised beforehand with ammonia by means of mercurous nitrate. The deposit formed is of an orange colour. If we add even a slight excess of ammonia there is formed a complex greyish or blackish precipitate. It may then be proved that the filtered liquid contains no vanadium. The precipitate, if gently heated in a Rose's crucible, traversed by a current of hydrogen sulphide, leaves as a residue merely vanadium sulphide. This method may, therefore,

be used for isolating or determining vanadium. The determination is made then either in the state of sulphide or of vanadic acid.

Mercuric Salts.—Mercuric chloride produces no precipitate with the vanadates, if the solution is acid; if we saturate it exactly with ammonia there is formed a light yellow precipitate; in a liquid which has been neutralised beforehand, and decolourised, the precipitate is white. The precipitation of the vanadic acid is complete, and it may be utilised, as in the former case, for the determination of vanadium.

Salts of Lead.—The mixture of lead nitrate and vanadate in a slightly acetic solution gives rise to a light yellow precipitate; in a slightly ammoniacal solution the deposit is of a yellowish white. In either case the vanadic acid may be almost entirely precipitated if the liquid is approximately neutral.

Salts of Bismuth.—Bismuth nitrate likewise forms, with a vanadate, a yellowish white liquid on saturating the liquid with ammonia. There does not remain a trace of vanadic acid in the liquid. If the liquid is slightly nitric there is produced, on boiling, an orange precipitate, generally incomplete. Boiling after the addition of sodium acetate gives a bright yellow precipitate, which may be complete. On ignition it turns orange, but becomes bright yellow again on cooling. This reaction is an additional analogy between vanadic acid and the phosphoric and arsenic acids.—*Comptes Rendus*, Vol. cv., p. 119.

TURQUOIS FROM NEW MEXICO.*

By F. W. CLARKE and J. S. DILLER.

AT Los Cerillos, New Mexico, about twenty-two miles south-west of Santa Fé, are mines of turquois which have been worked for centuries. The locality has been repeatedly described,† from archæological and geological points of view; but, as far as we are able to ascertain, the turquois itself has never been fully analysed, nor has it been subjected to complete microscopic study. Having at our disposal a very full suite of specimens, collected during the summer of 1885 by J. W. Powell, Director of the U.S. Geological Survey, we have thought it desirable to investigate the subject more thoroughly, and to present our results in such form as to render them readily comparable with the published data concerning turquois from other localities.

The turquois occurs imbedded in its matrix, sometimes in nodules, oftener in seams or veins. It varies in colour very widely; ranging from a pure sky-blue, through many shades of bluish green and apple-green, to dark greens which show no blue whatever. The dark green nodules often shade off to nearly white at the centre, sometimes resembling in structure, as Blake has observed, certain varieties of malachite. Many of the specimens are seamed or streaked by limonite, which has been derived from accompanying pyrite; and the latter mineral occasionally is found, bright and unaltered, enclosed completely in masses of clear blue turquois.

For analysis, three samples of turquois were selected, representing as nearly as possible the most definite types of the mineral. They may be summarily described, as follows:—

A. Bright blue, faintly translucent in thin splinters.

B. Pale blue, with a slight greenish cast, opaque and earthly in lustre, and of sp. gr. 2·805. Blake gives the density from 2·426 to 2·651 for the green variety.

C. Dark green, opaque.

	A.	B.	C.
H_2O	19·80	19·60	18·49
Al_2O_3	} 39·53	36·88	37·88
Fe_2O_3		2·40	4·07
P_2O_5	31·96	32·86	28·63
CuO	6·30	7·51	6 56
SiO_2	1·15	0·16	4·20
CaO	0·13	0·38	undet.
	98·87	99·79	99 83

Analysis "A" is not quite complete, for enough material could not be obtained without the destruction of too valuable specimens. The silica in it was due to traces of admixed rock from which the material could not well be perfectly freed. "C," however, was free from rock; and the silica in it must be accounted for otherwise. Silliman reports the turquois as containing 3·81 of copper, which corresponds to 4·78 of CuO; but he gives no other quantitative data.

In attempting to discuss these results it will be well to compare them with two other published analyses of turquois from different localities. First, we have the figures given by Church* for the well known variety from Persia; and secondly, the analysis by G. E. Moore† of turquois, pseudomorphous after apatite, from Taylor's Ranch, Fresno County, California.

	Persia	California.
H_2O	19·34	19·98
Al_2O_3	40·19	35·98
Fe_2O_3		2·99
FeO	2·21	
P_2O_5	32·86	33·21
CuO	5·27	7·80
MnO	0·36	
	100·23	99·96
Sp. gr.	2·75	2·798, 2·815

These analyses, leaving temporarily out of account that of the dark-green variety, agree well with each other in their atomic ratios. Dividing the percentages by the proper molecular weights, and treating the bases together, the following ratios appear.

	Total base.	P_2O_5.	H_2O.
New Mexico, A ..	0·468	0·225	1·100
New Mexico, B ..	0·479	0·231	1·089
Persia	0·492	0·231	1·075
California	0·470	0·234	1·110

In each case the base stands to the acid in a ratio very slightly in excess of two to one; and that excess may fairly be accounted for upon the supposition that it represents a trifling admixture of limonite. The water is present in a proportion a little under that of five molecules to one of phosphoric acid, the variation here being due to the differences in the percentages of copper. If we calculate the amount of phosphoric acid necessary to satisfy the alumina, and then reckon the phosphate so obtained as requiring five molecules of water, we shall have left over a quantity of copper, acid, and water corresponding to a very simple formula; and the turquois will appear as a variable mixture of the two following salts:—

$$2Al_2O_3.P_2O_5.5H_2O.$$
$$2CuO.P_2O_5.4H_2O.$$

In the Californian turquois the analytical results fit these formulæ quite sharply, and give the ratio between the two compounds as approximately four to one. The first formula may be regarded as that of normal turquois, and may be written in rational form, halved, as

$$Al_2HPO_4(OH)_4.$$

* From the *American Journal of Science*, vol. xxxii.

† W. P. Blake, *American Journal of Science*, II., xxv., 227, 1858. J. S. Newberry, "Report of the Exploring Expedition from Santa Fé to the Colorado," &c., 1859; printed, 1876. B. Silliman, *American Journal of Science*, III., xxii., 67, 1881.

* CHEMICAL NEWS, x., 290. Dana's "Mineralogy," p. 581.

† V. von Zepharovich and G. E. Moore, *Zeitsch. für Kryst. u. Min.*, x., 240.

The copper salt, to which the mineral owes its colour, is to be considered merely as an impurity; a view which is emphasized by the analysis of the dark-green turquois, "C." In the latter case the same ratios apply, modified by the presence of silica, which is nearly sufficient to form with the copper a normal metasilicate, similar to if not identical with chrysocolla. This silicate, with whatever blue tinge of colour it might have, affected by the yellow or brown of the iron present, probably gives the turquois its green hue. It is exceedingly probable that the purity of tint in gem turquois is due to the copper salt alone; and that degradations of the colour towards green are ascribable to admixture of salts of iron. It is noteworthy that, of the three turquoises analysed, the bluish contains the lowest percentage of copper. This could hardly be the case were not the colours of the other samples modified by some impurities; and compounds of iron would naturally produce an effect in the observed direction.

Sections of the three varieties of turquois were studied under the microscope, and found to be of essentially the same character. Although deeply coloured in the hand specimens, the thin sections appeared almost clear and transparent. Between crossed nicols the deep blue and green forms were seen to be composed of minute grains, or short, thick fibres; but in the paler varieties the fibrous structure was more pronounced. The optical properties of both grains and fibres are the same throughout. They are all weakly doubly refracting, but have a rather high refractive index. The finely granular portions have a pale bluish aggregate polarisation, less intense than that of chlorite; but when the mineral is distinctly fibrous it polarises like some forms of serpentine, with light colours of the first order. The fibres are generally somewhat bent and interwoven, but lie approximately in the same direction. Each fibre becomes dark when parallel to the principal section of either of the crossed nicols, indicating that they must crystallise according to either the quadratic, hexagonal, or rhombic system, instead of in one of the inclined systems, as was the case with the fibres studied by Bücking* in the turquois of Fresno County, California.

A section was prepared of a distinct vein of pale green turquois, which showed that the fibrous structure is directly across the vein perpendicularly to its walls. Small fissures, running into or across the veins, have the fibres of turquois arranged perpendicularly along their sides, just as serpentine arranges itself along fissures in olivine. Sometimes the fissures are minute and curved; but the resulting arrangement does not simulate the radial fibrous or spherulitic structure described by Bücking† as found in the turquois of California, Nevada, and elsewhere.

The perpendicular arrangement of the turquois fibres along fissures crossing the vein, indicates that the mineral may have been derived from the alteration of another substance with which the vein was formerly filled. We would suppose, of course, that the original vein material was itself a phosphate; and the only one after which turquois is known to be pseudomorphous is apatite; a species which not infrequently occurs in veins. The opinion that the turquois has resulted from such an alteration is favoured by the presence of other alteration products, to be noted in considering the composit on of the country rock in which the turquois it found. It is also suggested by Hermann's analysis of blue oriental turquois, in which the equivalent of 3·41 per cent of calcium phosphate was actually determined.‡

The rock in which the veins of turquois occur is described by Blake as "a granular porphyry, yellowish, grey, or white in colour, porous and earthy in texture. It decomposes rapidly by weathering, and very much resembles a sandstone." In the collection made by Major Powell there are several good examples of the rock penetrated by the turquois. It is a fine grained, reddish, felspathic rock, mostly fresher than that described by Blake, and it has a microgranitic aspect. It contains numerous particles of biotite and pyrite, with stainings of oxide of iron. The hand specimens look as though they had been crushed, and the fissures thus formed so filled as to produce irregular veins and nodules. The veins are small, and mostly composed of turquois, in which are imbedded a few scales of biotite, particles of pyrite, and considerable quartz and oxide of iron. Scales of biotite are found abundantly in the iron-stained cavities, as well as in the solid portions of the rock. Some specimens of rock, containing much pale blue turquois of earthy texture, have been completely kaolinised, and a partial analysis of the kaolin gave the following results:—

H_2O	12·88
SiO_2	52·38
$Al_2O_3 + Fe_2O_3$	33·49
P_2O_5	none
MgO	1·17
CaO	trace
	99 92

Although the mineral itself was white, the alumina from it was distinctly reddish with the iron.

Under the microscope the rock is seen to be composed chiefly of felspar, with a considerable amount of biotite, epidote, pyrite and limonite, and some amorphous substance. It is somewhat microgranitic in structure, and the irregular, interlocking grains of felspar vary in size from 0·01 to 0·8 m.m. in diameter. Most of them are consideraby kaolinised, so as to appear cloudy in ordinary light; but between crossed nicols the original outlines of the grains become more distinct. Their optical properties indicate that the felspar is orthoclase; an opinion which is fully borne out by the subjoined analysis of the rock, which shows a remarkably large proportion of potash.

H_2O	3·28
SiO_2	56·68
Al_2O_3	16·62
Fe_2O_3	6·50
P_2O_5	0·73
MgO	0·79
CaO	0·59
CuO	trace, undet.
MnO	1·02
FeS_2	2·21
K_2O	11·18
Na_2O	1·03
	100·63

The porphyritic crystals are generally Carlsbad twins with irregular outlines. There are occasionally small grains of fresh, transparent plagioclase, which has evidently resulted from alteration.

The biotite of the rock occurs in noteworthy quantities, but is very unequally distributed. It is frequently aggregated in groups of scales, and may be seen most abundantly in small cavities. It sometimes occurs intimately associated with the turquois, but unlike the latter it is one of the primary minerals. The small quantity of quartz present is a secondary product, so intimately associated with turquois as to suggest their genetic connection. Pyrite is scattered rather uniformly throughout the rock in small cubical crystals easily seen in the hand specimen. They are sometimes altered to limonite, but in other cases they have been completely replaced by pseudomorphs of epidote. The specimen of rock which was subjected to analysis probably contained an amount of pyrite rather greater than the average.

One of the most important constituents of the rock, because of its very close association with the turquois, occurs in the form of bright yellow grains. They are not distinctly pleochroic, but have a high refractive index, with strong double refraction, and give brilliant aggregate

* See paper by v. Zepharovich and Moore, previously cited.
† *Zeitsch für Kryst. und Min.*, ii., p. 103.
‡ See Dana's "System of Mineralogy," p. 581.

polarisation. The particles are usually very small, and grouped together in irregular compound grains so as to suggest nothing of crystallographic form. In several cases, however, elongated simple grains show inclined extinction; which indicates that the mineral must be either monoclinic or triclinic in crystallisation. Judging not only from the properties enumerated, but also from the percentage of lime in the rock, this mineral is in all probability epidote. It is evidently connected genetically with the turquois, for it is almost uniformly found upon the border of the latter, and is most abundant in its neighbourhood.

Concerning the origin of the turquois bearing-rock, it may be stated that Professors Newberry and Silliman, both of whom studied it in the field, regard it as eruptive, and probably of Tertiary age. The occurrence of this veritable orthoclase rock in the West is of special interest from the facts disclosed by recent investigations that in many of the rocks previously described as trachytes the predominating felspar is plagioclase.

The very small size of the veins and their limited distribution show that the turquois is of local origin, and emphasizes the idea that it has resulted from the alteration of some other mineral. In addition to the evidence already cited to show that the turquois has been derived from apatite, we have the fact that epidote, a lime-bearing mineral, is present as a secondary product. The oxidation of pyrite may have had something to do with initiating the process of alteration, and the alumina of the turquois was probably derived from decomposing felspar. The latter suggestion was made by Silliman, who also examined microscopic sections of the rock, and reported apatite as present. No apatite, however, could be seen in the specimens examined by us. A search for it at the locality would certainly seem to be desirable.

TYROTOXICON: ITS PRESENCE IN POISONOUS CHEESE, ICE-CREAM, AND MILK.*

By VICTOR C. VAUGHAN.

Poisonous Cheese.

Historical.—The learned poet and chemist, Justinus Kerner, first made experimental investigations concerning the nature of certain foods which become poisonous by fermentation, or more properly by putrefaction. Kerner's first work was published in 1817.† This was devoted to poisonous sausage, and in this work we find that the author concluded that the poisonous principle consisted of a fatty acid analogous to the sebacic acid of Thenard. Later, Kerner modified this opinion, and announced his belief that the poisonous substance consisted of a fatty acid combined with a volatile base.‡ Dann, following Kerner, believed the active principle of poisonous sausage to be an acrid, empyreumatic oil, which when pure is not poisonous, but is rendered so by combination with fatty acids.§ Buchner describes a botulinic acid which he conceived to be the active agent. Other observers also attributed the poisonous effects to fatty acids.

These statements in regard to poisonous sausage have been made on account of the similarity of the effects of poisonous sausage and poisonous cheese, and to call attention to the general belief of the older investigators that the active agent was in some way intimately connected with the fatty acids.

In 1827 Professor Hünnefeld made some analyses of poisonous cheese, and experimented with extracts upon the lower animals.* He accepted the ideas of Kerner in a somewhat modified form, and thought the active agents to be caseic and sebacic acids. About the same time Sertürner, making some analyses of poisonous cheese for Dr. Westrumb, also traced the active agents, as he supposed, to sebacic and caseic acids.† We see from the above that during the first part of the present century the fatty acid theory, as we now call it, was generally accepted.

In 1844 Dr. Christison, after referring to the work of Hünnefeld and Sertürner, makes the following statement:—"His (Hünnefeld's) experiments, however, are not quite conclusive of the fact that these fatty acids are really the poisonous principles, as he has not extended his experimental researches to the caseic and sebacic acids prepared in the ordinary way. His views will probably be altered and simplified if future experiments should confirm the late inquiries of Braconot, who has stated that Proust's caseic acid is a modification of the acetic cambined with an acrid oil."‡

In 1852 Schlossbergerger made experiments with the pure fatty acids, and demonstrated their freedom from poisonous properties.§ These experiments have been verified repeatedly, so that now it is well known that all the fatty acids obtainable from cheese are devoid ot poisonous properties.

It may be remarked here that there is every probability that the poisonous substance was present in the extracts obtained by the older chemists. Indeed we may say that this is a certainty, since the administration of these extracts to cats was—in some instances at least—followed by fatal results. The great mass of these extracts consisted of fatty acids, and as the chemists could find nothing else present they very naturally concluded that the fatty acids themselves constituted the poisonous substance.

Since the overthrow of the fatty acid theory, various other conjectures have been given, but none of them are worthy of credit.

We make the following quotations from some of the best recent authorities on the subject to show their opinions:—

"Nothing definite is known of the nature of cheese poison. Its solubility seems established from an observation of Hussemann,—a case in which the poison was transmitted from a nursing mother to her child." ‖

"The older investigations of the chemical nature of cheese poison, which led to the belief of 'putrefactive cheese acids' and other problematic substances, are void of all trustworthiness, and the discovery of the active principles of poisonous cheese may not be looked for in the near future, on account of proper animals for controlling the experiments with the extracts, as dogs can eat large quantities of poisonous cheese without its producing any effect."¶

"All kinds of conjectures concerning the nature of this poison have been formed, but all are even devoid of historical interest, because they are not based upon experimental investigations. My own experiments towards solving this question have not progressed very far." **

Other authorities might be cited, but all state substantially the same thing.

History of the Michigan Cases.—In the years 1883 and '84 there were reported to the Michigan State Board of Health about 300 cases of cheese poisoning. As a rule

* Read before the Chemical Section of the American Association for the Advancement of Science, August, 1886.

† "Dass Fettgift oder die Fettsaeure und ihre Wirkungen auf dem Thierischen Organismus," &c. Stuttgart und Tubingen, 1817. Hiller gives the date of Kerner's first paper as 1782, but Kerner was not born until 1786.

‡ "Die Neuste Vergiftungen durch Verdorbene Wuerste," &c. Carlsruhe, 1821.

§ *Horn's Archiv.*, 1828, B. 1, S. 596.

* *Horn's Archiv*, B. 1, S. 203.

† *Ibid.*, B. 1, S. 65.

‡ "A Treatise on Poisons." First American from the fourth Edinburgh edition, p. 496.

§ *Archiv f. Physiologische Heilkunde*, 1853.

‖ Dr. Arnold Hiller, "Die Lehre der Faulniss." Berlin, 1879 S. 197.

¶ Hussemann, "Real-Encyclopedia der gesamten Heilkunde," 1881 B. VI., S. 313.

** Brieger, "Ueber die Ptomaine," 1885, S. 50.

the first symptoms appeared within from two to four hours after eating of the cheese. In a few the symptoms were delayed from eight to ten hours, and were very slight. The attending physicians reported that the gravity of the symptoms varied with the amount of cheese eaten, but no one who ate of the poisonous cheese wholly escaped.

One physician reported the following symptoms:—"Every one who ate of the cheese was taken with vomiting; at first of a thin, watery, later a more consistent reddish-coloured substance. At the same time the patients suffered from diarrhœa with watery stools. Some complained of pain in the region of the stomach. At first the tongue was white, but later it became red and dry, pulse was feeble and irregular; countenance pale, with marked cyanosis. One small boy, whose condition seemed very critical, was covered all over his body with bluish spots.

Dryness and constrictions of the throat were complained of by all. In a few cases the nausea and diarrhœa were followed by marked nervous prostration.

Notwithstanding the severity of the symptoms in many, there was no fatal termination. Many of the physicians at first diagnosed the cases from the symptoms as due to arsenical poisoning, and administered ferric hydrate. Others gave alcohol and other stimulants, and treated upon the expectant plan.

The Poisonous Cheese.—All of these 300 cases were caused by eating of twelve different cheeses. Of these nine were made at one factory, and one each at three other factories. Of each of the twelve I received smaller or larger pieces. Of each of ten I received only small amounts. Of each of the other two I received about 18 kilos. The cheese was in good condition, and there was nothing in the taste or odour to excite suspicion. However, from a freshly cut surface there exuded numerous drops of a slightly opalescent fluid, which reddened litmus instantly and intensely. (Although, as I have stated, I could discern nothing peculiar in the odour, if two samples—one of the good, the other of poisonous cheese—were placed before a dog or cat, the animal would invariably select the good cheese. But if only poisonous cheese was offered, and the animal was hungry, it would partake freely.) A cat was kept seven days and furnished only with poisonous cheese and water. It ate freely of the cheese and manifested no untoward symptoms. After the seven days the animal was etherised, and abdominal section was made. Nothing abnormal was discovered. I predicted, however, in my article on poisonous cheese,* that the isolated poison would affect the lower animals. As to the truth of this prediction we will see later.

My friend Dr. Sternberg, the eminent bacteriologist, found in the opalescent drops, above referred to, numerous micrococci. Inoculation of rabbits with these failed to produce any results.

Extracting the Poison.—At first I made an alcoholic extract of the cheese. After the alcohol was evaporated *in vacuo*, at a low temperature, a residue consisting mainly of fatty acids remained. I ate a small bit of this residue, and found that it produced dryness of the throat, nausea, vomiting, and diarrhœa. For some weeks I endeavoured to extract the poison from these fatty acids, but all attempts were unsuccessful. I then made an aqueous extract of the cheese, filtered this, and, drinking some of it, found that it also was poisonous. But after evaporating the aqueous extract at 100° on the water-bath, this residue was not poisonous. From this I ascertained that the poison was volatile at or below the boiling-point of water. I then tried distillation at a low temperature, but by this the poison seemed to be decomposed.

Finally, I made the clear, filtered aqueous extract, which was highly acid, slightly alkaline with sodium hydrate, agitated this with ether, removed the ether, and allowed it to evaporate spontaneously. The residue was highly poisonous. By re-solution in water and extraction with ether the poison was separated from foreign substances. As the ether took up some water this residue consisted of an aqueous solution of the poison. After this was allowed to stand for some hours *in vacuo* over sulphuric acid, the poison separated in needle-shaped crystals. From some samples the poison crystallised from the first evaporation of the ether and without standing *in vacuo*. This happened only when the cheese contained comparatively a large amount of the poison. Ordinarily the use of the microscope was necessary to detect the crystalline shape. From 16 kilos. of one cheese I obtained about 0·5 grm. of the poison, and in this case the individual crystals were plainly visible to the unaided eye. From the same amount of another cheese I obtained only about 0·1 grm., and the crystals in this case were not so large. I have no idea, however, that by the method used all the poison was separated from the cheese.

Properties of the Poison.—I have called this poison tyrotoxicon (cheese poison). It gives, with potassium ferricyanide and ferric chloride, Prussian blue. It also reduces iodic acid. However, I do not consider either of these reactions characteristic, and a number of other substances will also give them. Peptones, a small amount of which is present in all milk, will give these reactions. The ordinary alkaloidal reagents failed to produce any precipitate with tyrotoxicon. The crystals have a penetrating old-cheesy odour, and it is interesting in this connection to state that Hussemann and Bœhm have both observed this odour in poisonous sausage. If the crystals be allowed to stand exposed to the air, at ordinary temperature, they decompose with the formation of an organic acid whose nature has not been determined. Tyrotoxicon is soluble in water, alcohol, chloroform, and ether. I am sorry that I have not been able to obtain this substance in quantities sufficient for an ultimate analysis. But the smallness of the amounts obtained and the rapid decomposition of the poison has prevented any such analysis.

The physiological test for the poison I regard as the only certain one. A few drops of an aqueous solution of these crystals placed upon the tongue produced the symptoms already described as characteristic of poisonous cheese. This was tried repeatedly upon myself and upon some of my students who kindly offered themselves for experimentation.

The Poison in Milk.

In November, 1885, a student brought to me a 4-ounce bottle partly filled with milk which had stood tightly closed with a glass stopper for about six months. From this I succeeded in isolating the same poison. It was recognised by its crystalline appearance and by its effect upon myself. It was presumed that this milk was normal in composition when first obtained; but of this we could not be certain.

I then put several gallons of normal milk in perfectly clean bottles with glass stoppers, and allowed these to stand in my work room. From time to time a bottle was opened, and the test for tyrotoxicon was made. These tests were followed by negative results, until about three months after the experiment was begun. I then succeeded in getting the poison from one of the bottles. The method for testing for it was as follows:—The coagulated milk was filtered through heavy Swedish filter-paper. The filtrate was colourless and decidedly acid in reaction. It was rendered feebly alkaline by the addition of potassium hydrate, then agitated with ether. After separation the ethereal layer was removed with a pipette, allowed to run through a dry filter-paper to remove a flocculent white substance which floated in it, and then allowed to evaporate spontaneously. If necessary this residue was dissolved in water and again extracted with ether. On the evaporation of the ether the tyrotoxicon was recognised by its crystalline appearance, by its odour, and by

* "Ein Ptomain aus giftigem Kase." *Zeitschrift fur Physiol. Chemie*, B. x., S. 146.

placing a small bit on the tongue. As the ether takes up some water, there is usually enough of the latter left after the spontaneous evaporation of the ether to hold the poison in solution, and in order to obtain the crystals this aqueous solution must be allowed to stand for some hours *in vacuo* over sulphuric acid.

From one-half gallon of milk there was obtained quite a concentrated aqueous solution of the poison after the spontaneous evaporation of the ether. Ten drops of this solution placed in the mouth of a small dog, thret weeks old, caused, within a few minutes, frothing at the mouth, retching, the vomiting of frothy fluid, muscular spasm over the abdomen, and after some hours watery stools. The next day the dog seemed to have partially recovered, but was unable to retain any food. This condition continuing for two or three days, the animal was killed with chloroform. No examination of the stomach was made.

It may be remarked here that I have elsewhere pointed out the necessity of using pure ether for these extractions, as some samples of ether contain an irritating ptomaine-like substance.

(To be continued.)

CORRESPONDENCE

ESTIMATION OF THEINE.

To the Editor of the Chemical News.

SIR,—I observe that in a recent contribution to the *Farmatzevtitchesky Jurnal* (No. 12, 1887, p. 177), Prof. Loesch, of St. Petersburgh, has given an account of a process for the estimation of theine in tea, consisting in the extraction of the tea-leaves with boiling water, evaporation of the infusion on a water-bath after addition of magnesia, and extraction of the residue with chloroform.

This process, as many other chemists who, besides myself, must have used it can no doubt testify, is an excellent one, but it is certainly not new. I have employed it for the past six years (with the modification of extracting the tea-leaves in a flask provided with a vertical Liebig's condenser), and like it better than any other process for the determination of theine. It answers, of course, equally well in the analysis of coffee.—I am &c.,

E. GODWIN CLAYTON, F.C.S., F.I.C.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Seances, de l'Académie des Sciences. Vol. civ., No. 26, June 27, 1887.

Determination of the Quantity of Potassium Disulphate in a Dilute Liquid.— E. Bouty.— If we wish to apply the measure of conductivities to the absolute determination of the quantity of potassium disulphate in a dilute liquid, we are confronted by a first difficulty ; we cannot determine the conductivity of the pure disulphate, this salt being always accompanied, in dilute solutions, by sulphuric acid and potassium sulphate. Still we may, without a notable error, confound the conductivities of the acid and the neutral sulphate. Potassium disulphate is especially stable in hot and concentrated liquids. An excess of neutral sulphate is more favourable than an excess of acid.

Decomposition of Hyposulphites by Acids.—G. Foussereau.—If we operate on a mixture containing, per litre, 1-12th equivalent of the two reagents, and capable of becoming turbid at once, the electric resistance increases at first very rapidly, then more and more slowly, reaching, after about ten days, a limit equal to $\frac{5}{4}$ of the primitive resistance. The decomposition of the hyposulphurous acid is therefore completed progressively. If we operate upon very dilute mixtures containing from 1-10ooth to 1-20ooth equivalent per litre, the increase of resistance begins at once, but very slowly. It quickens progressively during the first days, attains a maximum speed after about forty days, then slackens and ceases. The final resistance is again about $\frac{5}{4}$ of the original resistance.

On Ammonium Vanadates.— A. Ditte.— A general study of the vanadates, whether prepared in the moist or the dry way, shows that they belong to the following definite types : — $3VO_5MO$; $2VO_5MO$, $3VO_5,2MO$ for the acid salts ; VO_5MO for the neutral compounds, and VO_52MO, VO_53MO, VO_54MO, for the basic salts. The author has not met with the formula $5VO_53MO$, ascribed to certain salts by some authors.

Solubility of Uric Acid in Water.—MM. Blarez and G. Denigès.—One hundred grms. of water dissolve 2 m.grms. of uric acid at 0°, and 62·5 at 100°.

On Ferric Chloride Hydrochlorate.—Paul Sabatier. —The author has obtained this compound by exactly the same process as far back as 1881 (*Bulletin de la Société Chimique*, 2nd series, p. 197).

Study of the Reactions of the Vanadiates from an Analytical Point of View.—A. Carnot.—(See p. 42).

The Identity of Dambose and of Inosite.— M. Maquenne.—Dambose is strictly identical with the inosite of leaves or of muscles, and dambonite should be considered as the dimethyline of inosite. The term dambose ought to be expunged from chemical nomenclature.

On Mono-nitro-acenaphthene.—E. Jandrier.—This compound is formed on adding, drop by drop, nitric acid of 1·34 sp. gr., to a hot saturated solution of acenaphthene in glacial acetic acid. It crystallises from alcohol, ether, or acetic acid in white silky tufts, fusible at 155°.

Moniteur Scientifique, Quesneville. Series 4, Vol. i., April, 1887.

Researches on Titanium.—Otto von der Pfordten.— This voluminous treatise is taken from the last year's volume of *Liebig's Annalen.*

Purification of Water.— W. Anderson.— From the *Journal of the Society of Arts.*

Analysis of Opium.— Charles Stillwell.— From the *American Chemical Journal.*

Redondite and its Value for the Manufacture of Phosphates.—Walter Tate.— Taken from the *Journal of the Society of Chemical Industry.*

Measurement of the Rotatory Powers of Quartz.— Dr. G. Quesneville.—The author gives his results in the form of tables.

Manufacture of Strontium Hydroxide. — E. F. Trachsel.—From the *Journal of the Society of Chemical Industry.*

Industrial Preparation of Resorcine. — Dr. Otto Mühlhaüser.—For the industrial preparation of resorcine we melt sodium benzol-disulphonate with sodium hydroxide, thus obtaining sodium resorcinate, which is then decomposed with an acid, and the resorcine is extracted from its aqueous solution by means of ether or amylic alcohol. The product is then purified by distillation under a reduced pressure. The preparation of resorcine from benzol includes, therefore, the following operations :—Preparation of benzol-monosulphonic acid and then of the disulphonic acid ; preparation of resorcine by fusion, decomposition of the sodium salt, extraction, and purification. The final yield is 19 to 23 kilos. of pure resorcine from 125 kilos. sodium benzol-disulphonate.

Industrial Society of Mulhouse. Session of the Chemical Committee, January 12, 1887.—The secretary presented a sealed paper (No. 382, Oct. 27, 1883), deposited by R. Geigy, of Bâle, and opened at the general session of Jan. 26, 1887. It refers to a yellow colouring-matter discovered by Dr. J. Walter, chemist to the firm of Geigy and Co., and subsequently introduced into commerce as "solar yellow." The colour is obtained by the action of hot strong alkaline solutions upon para-nitro-cresyl-ortho-sulphonic acid. It dyes cotton a fine orange yellow without mordants. M. Casanovas sent in, through M. Noelting, a paper on white, blue, yellow, green, and black discharges on Congo reds, thus imitating the Turkey-red discharge styles. The principle of the method consists in reducing and discharging the Congo with stannous acetate, to which is added prussiate for blues, berry-liquor for yellows, and reduced logwood for blacks.

On Phenazine, the Initial Material of Toluylene Red, and of the Saffranines.—V. Merz and Bernthsen.—On heating orth-toluylene-diamine with pyrocatechine Merz obtained methyl-phenazine. The same compound was obtained by Bernthsen and Schweitzer by the decomposition of a colouring-matter belonging to the group of toluylene reds. Toluylene red, which is formed by the reaction of nitroso-dimethyl-aniline upon meta-toluylene diamine and oxidising the toluylene blue (indamine) thus obtained, contains an amidic group which may be removed by means of nitrous acid. The resulting product is very analogous to Witt's colour, *eurhodine*, prepared by the reaction of ortho-amido-azo-toluene upon α-naphthylamine, and belonging to the group of the quinoxalines. On diazotising this substance we obtain a compound, $C_{15}H_{15}N_3$, in fine needles or prisms of a garnet-red colour with a green reflection. It is distinctly basic, dissolves in dilute acids with a violet colour and in strong sulphuric acid with a red brown colour, which, on dilution, passes to a green, a blue, and finally to a violet with a fine golden-yellow fluorescence. It is to be regarded as dimethyl-amido-methyl-phenazine.

Nickel as Material for Capsules and Crucibles.—J. A. Wanklyn.

Laboratory Utensils of Nickel.—Bertram Blount.

Laboratory Utensils of Nickel.—T. Bruce Warren.

Laboratory Utensils of Nickel.—T. Tarrington.

Nickel Crucibles.—J. Dagger.

Detection of Impurity of Nickel and other Metals by Means of the Magnet.— T. Bruce Warren.— These papers are all from the Chemical News.

Justus Liebig's Annalen der Chemie,
Vol. ccxxxix., Part 1.

Delicacy of the Sense of Smell.—E. Fischer and Fr. Penzoldt.—The only trustworthy determinations of the quantities of substances necessary to excite the sense of smell have been hitherto carried out by Valentin. He found that the quantities thus capable of recognition were $\frac{1}{3000}$ m.g. bromine, $\frac{1}{20000}$ hydrogen sulphide, and $\frac{1}{200000}$ oil of roses. The authors have undertaken analogous experiments with other strongly smelling substances, and have arrived at still smaller values. For the experiments they used an empty room containing 230 cubic metres, with painted walls and a stone floor. Of the substance to be examined 1 grm. was weighed out, dissolved in 1 litre of pure alcohol, and 5 c.c. of this solution were again diluted with alcohol in known proportions. Of this last mixture from 1 to 3 c.c. were measured into a small flask closed with a cork provided with two bent glass tubes. The weighing, diluting, and measuring the odoriferous substance was carried on in the laboratory far distant from the room, and by a person not engaged in the experiment. For the experiment the contents of the flask were evaporated by one of the authors by means of a small hand-blast, all openings of the room having been first closed, which required from five to ten minutes, and the air of the room was then very carefully mixed and agitated for ten minutes by means of a large flag. At a signal the other author entered to test the odour. The result was further checked by an independent observer. In one of the experiments the quantity of merceptan evaporated was 0·01 m.g. This was faintly but distinctly recognised. The proportion of mercaptan to the air was in round numbers 1 : 50,000,000,000, and the quantity which could come in contact with the olfactory nerves was 1-460,000,000th m.g. This quantity is 250 times smaller than the quantity of sodium detected spectroscopically by Kirchhoff and Bunsen. Hence merceptan may be utilised in experiments on currents of air, the diffusion of gases, the efficacy of arrangements for ventilation.

MISCELLANEOUS.

The Cheshire Alkali Company, Limited.—We beg to direct the attention of our readers to the prospectus of this company which appears in our advertising pages. From all the information before us we should judge that the new undertaking has an excellent chance of success. The value of Dr. Pick's system has been already proved on the large scale in Austria. The estimate of 20 per cent returns on the capital to be subscribed will not appear extravagant if we remember that Brunner, Mond, and Co., Limited, for whom Dr. Pick was manager, have been paying 35 per cent per annum, in addition to carrying large sums to reserve. The new company will have the exclusive right of patenting Dr. Pick's improvements in any country except Austria and Germany.

Dr. A. W. Williamson.—We have received a circular bearing the signatures of Sir Henry Roscoe, Professor Odling, Professor Michael Foster, Professor G. C. Foster, Dr. Gladstone, and several other well known men of science, who have either been pupils of A. W. Williamson during the thirty-eight years that he has been Professor of Chemistry in University College, London, or have been otherwise intimately associated with him. In this circular it is suggested that Professor Williamson's resignation of his Chair affords a fitting opportunity for recording in some permanent manner the high appreciation of his influence as a scientific teacher and the feeling of personal regard for him as a man which are so generally entertained by those who know his work and character. It is accordingly proposed to ask him to sit for a portrait to be presented to University College, and subscriptions are invited for this purpose. As it is expected that the proposal will be widely responded to, one guinea is suggested as the ordinary amount of a subscription. Dr. W. J. Russell, F.R.S., 34, Upper Hamilton Terrace, N.W., has agreed to act as Honorary Treasurer of the fund to be collected, and Michael Carteighe, Esq., 36, Nottingham Place, W., and Dr. H. Forster Morley, University Hall, Gordon Square, W.C., have consented to be Honorary Secretaries.

TO CORRESPONDENTS.

B.P.S.—"The Methods of Glass-Blowing," by W. A. Shenstone.

A. Crosbie.—"Watts's Dictionary of Chemistry" is by far the best work of the kind in the English language.

BISULPHIDE OF CARBON,
CHLORIDE OF SULPHUR.
FRANKLIN BARROW,
CLAYTON
Near MANCHESTER.

THE CHEMICAL NEWS.

Vol. LVI. No. 1445.

THE ESTIMATION OF SILICON IN IRON AND STEEL.*

By THOMAS TURNER, Assoc. R.S.M., F.C.S., F.I.C.
Lecturer on Metallurgy, Mason College, Birmingham.

About three years ago the author published some observations on the estimation of silicon in iron and steel (*Jour. Chem. Soc.*, 1884, p. 260). In this paper a number of comparisons were made of the relative accuracy of certain methods of analysis commonly recommended; since that time several other methods have been tried, and some results recently obtained in the metallurgical laboratory appear to be of sufficient interest to bring before this Society.

It is customary in some ironworks in this country to estimate silicon in pig-iron by heating the sample with dilute sulphuric acid and evaporating to dryness; the residue is extracted with boiling water, and the insoluble portion, after treatment with hydrochloric acid, is carefully washed, ignited, and weighed. This method is recommended in "Mitchell's Assaying" (5th edit., p. 363) and other text-books; it possesses some advantages which recommend it in certain cases, as the solution and evaporation are easily performed, while the siliceous residue obtained is frequently as white as snow. It will be shown, however, that in some cases the method is apt to be misleading, and that the whiteness of the residue is no guarantee of its purity. In my own analyses by this method the procedure is as follows:—For a sample of cast-iron, 2 grms. of metal in the form of borings are placed in a clean beaker of about 8 ozs. capacity and covered with about 50 c.c. of water, 5 c.c. of sulphuric acid are then added, and the beaker kept covered while solution proceeds. The liquid is then evaporated till quite solid, after which it is extracted with 100 c.c. of boiling water. The insoluble portion is washed with boiling hydrochloric or nitric acid, and afterwards with water so long as any iron is extracted. It is necessary in all cases to test the filtrate by potassium ferrocyanide or theiocyanate. The insoluble portion is dried, ignited, and weighed in the usual way.

In the analysis of steels containing only a small quantity of silicon, results by this method agree fairly well with those obtained by other trustworthy processes. In pig-iron of specially good quality good results are also obtained, of which some examples may be given.

No. 3 *Hæmatite Pig.*—This sample had been examined by my friend Mr. J. P. Walton, of the Glasgow Iron Co., Wishaw, who obtained:—Silicon, 2·70 per cent; phosphorus, 0·04 per cent. Four determinations by students in the metallurgical laboratory gave respectively 2·61, 2·70, 2·75, and 2·78 per cent of silicon, the mean result being 2·71 per cent. Mr. C. H. New, by the sulphuric acid process, obtained 2·71 and 2·68 per cent, the mean being 2·695. The result of the whole analyses may be arranged thus:—

Mr. J. P. Walton	2·70 per cent.
Laboratory determinations	2·71 ,,
Sulphuric acid process	2·695 ,,

and it will be seen that the agreement is very satisfactory.

Lilleshall Cold Blast Pig.—This specimen I had previously examined by several methods, and obtained the following values (*Jour. Chem. Soc.*, 1884, p. 265):—

	Per cent SiO_2.
By treatment with HCl without evaporation	2·37
,, ,, ,, ,, and evaporation	2·52
,, ,, ,, ,, evaporation, and fusion	2·58
,, ,, ,, $HCl + HNO_3$ and evaporation	2·45
By treatment with $HNO_3 + H_2SO_4$ (Drown's method)	2·42
By combustion in chlorine	2·46

In each case the values are for silica (SiO_2) calculated as percentage on the original metal; probably the correct amount is 2·46 per cent. The sulphuric acid method gave 2·455 per cent of silica, a very close agreement.

In the previous cases a very superior class of pig was being examined, and under such circumstances the process gives every satisfaction. But unfortunately the majority of iron is less pure than the above mentioned, especially with regard to the amount of phosphorus present, and with such metal the method under consideration is very liable to be untrustworthy.

No. 4 *Northampton Pig.*—This sample was first examined by treatment with *aqua regia* and evaporation to dryness, the residue being extracted with hydrochloric acid and water alternately until the washings were free from iron. Practically it was found almost impossible to obtain a white residue by such treatment, for although the substance was boiled by decantation four times with strong hydrochloric acid and four times with water, and then very carefully washed on the filter, still, after ignition, a very distinct colour was usually observed. It is necessary to treat the precipitate either with strong hydrochloric acid or to fuse with acid sulphate of potash, or with fusion mixture, in order to obtain a pure siliceous residue.

It should be mentioned that this sample contained 1·84 per cent of phosphorus, and my experience with such samples leads me to believe that the siliceous residue firs t obtained on solution in an acid and subsequent evaporation is almost always contaminated with iron and a small quantity of phosphorus; on this account such residues should always be tested after ignition if accurate results are required. It appeared interesting to determine approximately the difference due to various amounts of impurity present in the residue after treatment with *aqua regia* and hydrochloric acid, as above described. The following table will illustrate this difference; in each case 2 grms. of the sample were taken for the experiment.

Method.	Weight of Precipitate.	Corresponding to Si per cent.	Colour of Precipitate.
Evaporation with $HCl + HNO_3$, imperfectly washed	0·139	3·24	Very brown.
Evaporation with $HCl + HNO_3$, washed better	0·131	3·05	Light brown.
Evaporation with $HCl + HNO_3$, well washed	0·1294	3·04	Red.
Evaporation with $HCl + HNO_3$, very carefully washed	0·1266	2·95	Light red.
Evaporation with $HCl + HNO_3$, treated with HCl after ignition	0·124	2·89	White.
Evaporation with $HCl + HNO_3$, after fusion and ignition	0·1204	2·81	Snow white.

From the above it will be seen that it is extremely difficult to thoroughly remove the last trace of iron from the residue after evaporation of phosphoric irons with *aqua regia*; the colour of the silica, however, serves as a

* Read before the Birmingham Philosophical Society, June 9, 1887.

very good index to its purity. In the case of other acids it is generally equally difficult to obtain a pure residue, but the colour is not so marked when an impurity is present. In the above sample on evaporation to dryness with sulphuric acid, a white residue was obtained which corresponded to 2·95 per cent of silicon. On fusion with acid potassium sulphate, both iron and phosphorus were extracted, and the snow-white silica left was equivalent to 2·73 per cent of silicon. It is evident, therefore, that with the sample in question, with careful working, the sulphuric acid method and the *aqua regia* process gave the same result; in each case this was too high, though with the sulphuric acid method there was little or nothing in the appearance of the precipitate to arouse suspicion.

In washing the residue students are more apt to make a mistake with the sulphuric acid method, as there is nothing in the colour of the solution or precipitate to indicate when the iron has been removed. It is therefore always necessary to test the washings until they are quite free from iron.

My attention was first strongly attracted to the sulphuric acid process by certain difficulties experienced in the analysis of a sample of very common Northamptonshire pig-iron. This had been analysed several times by the *aqua regia* method, and concordant results obtained, when I suggested to one of the students in the metallurgical department that its composition should be checked by dissolving in sulphuric acid. We were surprised to find that the check analyses gave very much higher results, although the residue was in all cases whiter by the sulphuric acid method than when *aqua regia* was used. In fact, the residue looked much better by the former method, though it was known to be less pure. By taking special care in washing the precipitate it gradually lost weight, until it was but little heavier than by the other process. But even when a constant weight was obtained, it was possible to extract nearly one-fifth of the substance by fusion with acid potassium sulphate and solution in cold water. The filtrate obtained after fusion contained titanium corresponding to 0·4 per cent of the original metal; it also contained a notable quantity of iron and a phosphate. It will be remembered that the iron in the residue did not turn red or brown on ignition, and from the conditions of its formation it is probable that this residue contained a basic compound, insoluble in acids, consisting of titanic oxide united with phosphoric acid and iron. There can be no doubt whatever as to the existence of these substances together in the white siliceous residue, but the exact form in which they occur is doubtful, as I have not succeeded in preparing a similar compound by evaporating titanium sulphate, sodium phosphate, and ferrous sulphate, with sulphuric acid.

I may mention that my friend Mr. Thomas Bayley was good enough to check some of my analyses of this sample, and substantially confirmed my conclusions; but we were sorry to find at the conclusion of our work that the drillings employed had been prepared by someone not familiar with such duties, and were contaminated with a little sand from the outside of the pig. Under these circumstances I have refrained from quoting the actual numbers obtained.

The conclusions arrived at from these experiments are as follows:—

1. That with cast-irons of specially good quality the silicon can be correctly estimated by evaporation with dilute sulphuric acid.

2. With phosphoric irons the residue obtained, though white, is often impure, and should be further treated in order to obtain accurate results.

3. With phosphoric irons containing titanium, the silica is contaminated not only with iron, but also with titanic oxide and phosphoric acid. The residue may be very nearly white and still contain 20 per cent of substances other than silica.

4. On treatment with *aqua regia* the colour of the residue is usually an indication of its purity.

RESEARCHES ON THE RELATIONS BETWEEN THE SPECTRA OF THE ELEMENTS OF INORGANIC SUBSTANCES AND THEIR PHYSIOLOGICAL ACTION.

By JAMES BLAKE.

In pursuing his researches always in the same direction the author has found that the action of a number of inorganic substances upon living matter depends on their isomorphic relations, and that all substances belonging to one and the same isomorphous group give rise approximately to the same physiological reactions. This fact was made known in a memoir read before the Royal Society of London in 1841, and it has been since confirmed by experiments made upon more than forty elements. Among all these elements there are only two whose physiological action does not agree with their isomorphic conditions,—nitrogen and potassium. When the same element forms two classes of salts belonging to distinct isomorphous groups, the physiological action of the salts of each class is quite different, but agrees with that of other substances of the group to which it belongs. Another fact observed by the author connects the physiological action of these substances to their molecular constitution,—*i. e.*, in one and the same isomorphous group the physiological action augments in intensity with the atomic weights of the elements present. The higher the atomic weight of an element the less of the substance is required to produce the same physiological reaction. This is a fact which demonstrates very distinctly the difference between these physiological reactions and ordinary chemical reactions. On considering the reactions of these substances from a physiological point of view, the author finds that it is by their action upon the nerve-centres of organic life, more or less specialised for each isomorphous group, that these reactions are explained. Thus the compounds of the alkaline metals act upon the internal ganglia of the heart; the compounds of phosphorus, arsenic, and antimony act upon the splanchnic ganglia; the substances of the magnesian group act upon the centre for vomiting; and in an analogous manner for other groups, it is by modifying the action of some nerve-centre that their physiological action is shown.

The spectroscope has opened out to us a path where physics and chemistry coalesce, where the molecular vibrations whose number we may count and whose length we may measure give rise to reactions of which we may grasp the results without having found the play of the forces by which they are determined.

Thanks to these discoveries which refer to the questions which engage us, the author considers that we are now in a position not merely to explain why chemistry could not render account of the results of his former experiments, but also find the direction in which must be sought the law which connects the physiological action of these inorganic substances with their physico-chemical properties.

In 1867 Mitscherlich discovered that the elements of one and the same isomorphous group have spectra which resemble each other, or are homologous. Still there are two elements, nitrogen and potassium, which form an exception to this rule, and these are the same two elements which form an exception to the rule, according to which the physiological action of the elements is connected with their isomorphous state. This fact has led the author to investigate if the action of these substances upon living matter is not connected to the molecular vibrations of which they are the seat, and which are revealed in their spectra. It is found that isomorphous substances give rise to the same physiological reactions when they have homologous spectra, but when in an isomorphous group there are found elements whose spectra do not resemble the spectra of other elements of the group, these elements with anomalous spectra give rise also to anomalous physiological reactions. When, as it has been said, an

element gives rise to two classes of salts the physiological action of these two substances is very different, and there is found a difference quite as strong between the spectra of the substances in the two classes. The physiological action of the elements in the various isomorphous groups shows that for two of these groups their action bears only upon the peripheric ganglionary centres: these are the group of the alkaline metals, and the group of phosphorus. As for the alkaline metals, the author has proved that after the injection of several grms. of sodium nitrate into its veins, an animal may live for a number of hours without any sign of a reaction given by a nerve-centre. The same fact reappears if we inject into the veins compounds of phosphorus, arsenic, and antimony. After the injection of 3 grms. arsenic acid into the veins we can observe no symptom which might indicate an action upon the cerebro-spinal nervous centres.

These two isomorphous groups have both very simple spectra. Of all the alkaline metals sodium and thallium have the simplest spectra. Their salts may be present in the blood in the greatest quantities in respect to their atomic weight, without reacting upon a central nerve-ganglion, whilst the salts of cæsium, with a more complicated spectrum, give rise to very slight symptoms when injected into the arteries. In the phosphorus group the same phenomenon is repeated. It is here again nitrogen with a very complex spectrum, which, of all the known elements reveals its presence by its action upon the nerve centres, and is distinguished in the sharpest manner from that of all the other elements of the same group. There are other facts which are better explained by referring them to the molecular vibrations of the reagents than by any other hypothesis. That the poisonous action increases with the atomic weight among substances having homologous spectra is a fact which is explained if we refer these physiological reactions to molecular vibrations. Further, the fact that these reactions rank among catalytic phenomena lends itself also to the same explanation better than to any other.

In the present state of our knowledge on the nerve vibrations, and also on the molecular vibrations, which hitherto lie hidden in the ultra-thermic region of the spectrum, the relation between molecular vibrations and physiological reactions remains, of necessity, a mere hypothesis; but the fine discoveries of M. Deslandres on the numerical relations subsisting among the molecular vibrations in spectra, promise to endow Science with a new means of approaching the problems of kinetic physiology. —*Comptes Rendus*, civ., p. 1544.

ON THE

INFLUENCE OF TEMPERATURE UPON SPECTRUM-ANALYTICAL OBSERVATIONS AND MEASUREMENTS.

By GERHARD KRÜSS.

Observations which the author has carried out for the purpose of determining the influence of temperature upon spectroscopic observations and measurements showed that this influence of temperature cannot be neglected and ignored, but must be considered by every chemist who wishes to make correct spectroscopic observations.

The more spectral analysis is applied as a sound method, the greater becomes the number of new observations and data added yearly to the facts already known.

In like proportion is increased the need for accurate localisation in the spectrum. Hence, for chemical researches in which we wish to depend upon the results of spectroscopic observations as *certainties*, the simple measurement by Bunsen's scale is no longer sufficient. It is now mostly supplemented by measuring arrangements like those mentioned by C. H. Wolff, the author, and others, which allow of the determination of localities in the spectrum being made with sufficient precision.

The accuracy which can apparently be reached by these methods has seldom been attained, as hitherto the temperature prevailing during spectroscopic measurements has seldom been taken into account.

The author was struck by this influence a considerable time back on determining the constants of his spectroscope on two days differing much in temperature.

Before entering upon the changes produced in the apparatus by differences of temperature it must be remembered that, according to the researches of Newton, Dale, Gladstone, Jamin, Schrauff, Landolt, and others, the refractive power increases in all liquids—excepting water between 0° and 4°—with the increase of density, *i.e.*, with the decrease of temperature. Rudberg showed that various solid bodies, such as quartz and arragonite, follow the same law, to which, however, there are exceptions. Among these is glass, in which, as proved by Arago and Neumann prior to Rudberg, the refractive power increases with the rise of temperature.

The following experiments were made to decide whether this decrease and increase of the refractive power of the prisms on changes of temperature, taken in conjunction with the changes of the other parts of a spectroscope due to the same cause have an appreciable influence upon spectroscopic measurements.

The universal spectroscope was fixed in a position convenient for the observer, and every agitation—indeed every superfluous contact—was carefully avoided. The room in which the apparatus was placed was heated to different degrees, and was each time kept for several hours as steady as possible at the same temperature. This was effected so completely that no variations occurred greater than 0·4°. The apparatus required from 1 to 1½ hours in order to completely adapt itself to a variation of 15° in temperature, wherefore the determinations were begun two hours after the apparatus was in air of a different temperature. In order to determine the influence of temperature upon these measurements it is sufficient to give the relative positions of four to five main lines of the solar spectrum in the numbers observed on the measuring drum.

From these numbers, which are given in a series of tables, it appears that the displacement of the spectral lines by temperature is considerable in comparison with the mean possible error of an observation. A difference of 25°, which is not impossible at different times of the year in work-rooms not constantly heated, may modify the position of the lines to the following extent:—With a glass prism of 60°, C may be displaced 7·5 towards the violet end of the spectrum, $\frac{D_1+D_2}{2}$ 7·67, E 9·83, *b* 7·50, and F 9·33 in the same direction. With a quartz prism having the same angle $\frac{D_1+D_2}{2}$ is displaced 4·10 towards the red extremity, E 2·27, *b* 6·36, and F 4·32. Therefore on a rise of temperature all phenomena of absorption and emission are displaced towards the violet with glass prisms, but towards the red with quartz prisms. These displacements are generally the greater the more refrangible the region of the spectrum in which they occur.

From 148 observations made by the author it appears that the mean error in localising a line is about 0·31 unit of the scale. As a difference of temperature of 1° effects a displacement of all lines by about 0·366 unit, a change of 1° in the temperature of a spectroscope can be observed with certainty.

In order to illustrate the errors which may be committed in spectroscopic determinations by neglect of the temperature the author gives in a table, under λ, the magnitude of the wave-lengths at 5°, and under λ_1 that which represents their position at 30°. From his table it may be seen that errors may spring from a neglect of the tem

perature in stating wave-lengths, since a rise of 5° is sufficient to transfer D_1 to the position of D_2. On a careful determination of the temperature many discrepancies in the statements of different authors may disappear.

Caution must especially be used in accepting the results of measurements which indicate displacements and distortions of lines in the spectra of the heavenly bodies.

The results, not merely of qualitative but of quantitative spectral analysis, will be rendered much more accurate by a due regard to temperature. This will especially occur when we are compelled to use parts of the spectrum whose neighbouring regions possess considerably larger or smaller absorptive powers than themselves.

The author points out the necessity of a general revision of the measurements of the spectra of the metals with regard to the temperature of the observation. Only an exact knowledge of the spark-spectra is of use to prevent such errors as the mistaken discovery of a supposed new metal.—*Liebig's Annalen*, Vol. ccxxxviii., p. 57.

TYROTOXICON: ITS PRESENCE IN POISONOUS CHEESE, ICE-CREAM, AND MILK.*

By VICTOR C. VAUGHAN.

(Concluded from p. 47).

Poisonous Ice-Cream.

June 13, 1886, I received from Dr. Henry Baker, Secretary of the Michigan State Board of Health, a pint bottle about two-thirds full of melted ice-cream, with the request that I would analyse it, as some eighteen persons had been seriously affected by eating of it. Dr. Baker also sent some of the vanilla which had been used as flavouring. It was thought that the poison would be found in the vanilla, because some lemon ice-cream furnished at the same gathering had not affected those who ate of it. As the readiest means of deciding this, my assistant Mr. Novie, and myself, took at first 30 drops each of the vanilla extract. No ill effects following this, Mr. Novie took two teaspoonfuls more, with no results. This settled the question of the poisonous nature of the vanilla more satisfactorily than could have been done by a chemical analysis.

We then added distilled water to the cream, and, after thorough agitation, filtered it. The filtrate was tested for tyrotoxicon by the method already given. The aqueous solution, after the spontaneous evaporation of the ether, was given to a cat. Within ten minutes the cat began to retch, and soon it vomited. This retching and vomiting continued for two hours, during which time the animal was under observation, and the next morning it was observed that it had passed several watery stools. After this, although the cat could walk about the room, it was unable to retain any food. Several times it was observed to lap a little milk, but on doing so it would immediately begin to retch and vomit. Even cold water produced this effect. This condition continuing, after three days the animal was placed under ether and its abdominal organs examined. We certainly expected to find marked inflammation of the stomach. But we really did find the stomach and small intestines filled with a frothy serous fluid, such as had formed the vomited matter, and the mucous membrane very white and soft. There was not the slightest redness anywhere. The liver and other abdominal organs seemed to be normal.

It should be remarked that this cat was about two months old. Attention is called to this, because young animals are affected by this poison much more readily than older ones. It requires a comparatively large amount of the poison to cause any marked symptoms in an old cat.

After having made these experiments I received from Dr. R. C. Moffitt, of Lawton, Mich., the following letter:—

"Lawton, Mich., June 21, 1886.

"Dear Doctor,—I understand from Prof. Charles Lawton, of this place, that the cream sent to Lansing, for examination, has been forwarded to you, so I write to give you the particulars. About two hours after eating the cream everyone was taken with severe vomiting, and after from one to six hours later with purging. The vomit was of a soapy character, and the stools watery and frothy. There was some griping of the stomach and abdomen, with severe occipital headache, excruciating backache and 'bone' pains all over, especially marked in the extremities. The vomiting lasted from two to three hours, then gradually subsided, and everybody felt stretchy, and yawned in spite of all resistance. The throats of all were œdematous. One or two were stupefied; others were cold and experienced some muscular spasms. A numb feeling, with dizziness and momentary loss of consciousness, was complained of by some. Temperature was normal, and pulse from 90 to 120. Tongue, dry and chapped. All were thirsty after the vomiting subsided, and called for cold water, which was allowed in small quantities, with no bad results. After getting out no one of the victims was able to be in the hot sun for several days, and even yet (about ten days after the poisoning) the heat affects myself. I attended twelve persons, besides being sick myself, and all were affected in pretty much the same way. Several complain yet of inability to retain food on the stomach without distressing them. The man who made the cream took a teaspoonful of it, and he vomited the same as those who ate a whole dish, but not so often nor for so long a time. All are affected with an irresistible desire to sleep, which can scarcely be overcome. Even yet some of us feel that drowsy condition, with occasional occipital headache.—Yours fraternally,

"R. C. Moffitt, M.D.

It will be seen from the above that the symptoms produced in the persons agree closely with those observed in the cat. Cases of poisoning from ice-cream are by no means rare, and I hope that those who have the opportunity will not fail to test for tyrotoxicon. In the Report of the Brooklyn Board of Health for 1885 an instance is given of the poisoning of more than 100 persons from ice-cream sent out from one restaurant. The chemist was unable to detect any mineral poison. The injurious results were attributed to the use of decomposed gelatin; but no gelatin of any kind was used in the Lawton cream. Other cases occurring in New York and Brooklyn have been attributed to the employment of artificially prepared vanillin for flavouring; but the vanilla extract used in the Lawton cream was not poisonous, as has been shown.

The circumstances under which tyrotoxicon develops require further study. As has been shown above it may develop in normal milk, kept in a clean bottle for three months; but it is evident that in some instances it appears much earlier. The production of the ptomaine is, in all probability, due, either directly or indirectly, to the growth of some micro-organism. In the cheese Dr. Sternberg found a new micrococcus; but whether or not there is any relation between this organism and the poison remains to be determined. In the cheese, milk, and cream, in all of which I have found the poison, there was present more or less butyric acid, and it may be that there is some intimate relation between butyric acid fermentation and the production of the poison. Some years ago Selmi obtained a ptomaine which resembles coniine, and pointed out that it might be formed by the action of butyric aldehyd on ammonia, thus:—

$$2C_4H_8O + NH_3 - 2H_2O = C_8H_{15}N.$$

* Read before the Chemical Section of the American Association for the Advancement of Science, August, 1886.

Or with butyric acid, thus :—

$$2C_4H_8O_2+NH_3+2H-4H_2O=C_8H_{15}N.$$

In like manner other fatty acids may react with the decomposing nitrogenous substances, forming alkaloidal bodies. Tyrotoxicon has no special resemblance, so far as is known, with coniine, but the possibility of these alkaloidal substances being formed in this way is worthy of mention. T. Lauder Brunton, in referring to the writer's discovery of tyrotoxicon, states that from the action of the substance he would infer the presence of two poisons. This is altogether possible. The writer has not been able to obtain the poison, as yet, in quantities sufficient to enable him to make an ultimate analysis of it. But that it is a chemical body produced by fermentation there can be no doubt.

If there be any doubt about the poison being produced by fermentation, the following experiment would seem to clear it up.

June 26th I took two samples, of one pint each, from a bottle of milk which had already undergone the lactic acid fermentation. These samples were placed in clean glass graduates. To one a piece of the solid portion of the poisonous custard, about the size of a filbert, and which had been washed with distilled water, was added. To the other no addition was made. These samples stood side by side for forty-eight hours. Both were then tested for tyrotoxicon. The one to which no addition was made gave no crystals, no odour, and when given to a cat produced no effect. The one to which the addition had been made yielded crystals which had the odour of tyrotoxicon, and which, when given to a very large old cat, produced frothing at the mouth and retching, but no vomiting or diarrhœa, and the next day the animal was able to eat food and seemed to have recovered. I am quite certain that had this been administered to a young animal the result would have been more marked.

It is well known that milk, while undergoing the lactic acid fermentation, does not possess any such poisonous properties as those belonging to tyrotoxicon. There is no evidence, then, that the poison is connected in any way with the ordinary decomposition of milk. The following extracts from a letter just received from the maker of the Lawton cream shows that the attention given to the milk and vessels was all that could be desired :—

"The milk of which the cream was made was fresh and sweet morning's milk, only reserving with it the cream of the milk of the night before from the same cows. The milk is kept in a cool, clean milk cellar. The custard was made about noon that day, and immediately afterwards the process of freezing was begun. The vessels were all thoroughly cleaned. There was no possibility of any impurities adhering to them, for they were scalded, wiped, and dried before being used. The only ingredients used were the milk, cream, eggs, sugar (best granulated), and the flavouring.

"The lemon cream was frozen first, then taken out, put into the packers, and packed solid with ice and salt. Then the vanilla cream was frozen in the same manner. I used the best Jennings's extract, about the usual quantity, not in excess. The cream was eaten in the evening by many people of the village. All of those who ate of the vanilla cream were made sick, and none of those who ate of the lemon cream suffered any inconvenience.

"Now the milk was the same in both, milked from the same cows the same morning that the cream was made, so that there was no difference in the custard used in making the vanilla cream and the lemon cream, but it turned out that the one made people sick and the other did not."

"We have continued making cream since in the same manner, without the least change of the ingredients or the apparatus, except we have not used vanilla extract, but lemon and pine-apple, and it has been freely eaten and no one has been made sick by it.

"Clearly in my mind the milk does not account for the trouble. One thing further: of course the cream which you examined has been made since the 9th day of June, and may have undergone changes which would result in generating the poison referred to in the papers [certain newspaper accounts of the finding of the poison], and which would not have been found in the cream had it been examined when fresh.

"If there is anything farther that I can furnish you in regard to facts or circumstances in connection with the ice-cream, I will be willing at any and all times to give the fullest information possible. Hoping to receive the correct analysis soon, I remain yours respectfully,

"J. W. JOHNSON."

That the poison which I found in the cream was the same as that which affected the people cannot be doubted after comparing the symptoms produced in the cat with those observed by Dr. Moffitt; and, as has been stated. the experiment on the cat was made before I received the letter from Dr. Moffitt. The cream was made on the 9th of June, and the poison separated on the 14th.

I wrote to Mr. Johnson asking several questions, which he has kindly and fully answered. As the nature of the questions is shown in the answers, I will simply give the answers :—

"(1.) The milk from all the cows was mixed together in the making of the custard."

"(2.) The custard for the lemon and vanilla was all one custard; made and mixed before the extracts were put in."

"(3.) We had previously used the same brands of extracts (Jennings's best), both lemon and vanilla, with no bad results."

"(4.) The food of the cows in the morning and evening consists of oats and corn, ground together and fed dry, with clover hay. I have never seen anything suspicious in the pasture or food. There is a running stream of water, coming from a spring in the pasture. There is plenty of shade. At evening the cows are driven from the pasture and placed in the stable or yard, according to the season. The stable and yard are open for inspection at any time. My residence is in the centre of the village, and the Board of Health would not allow me to stable and yard my cows there if there were any bad odours during the summer."

"(5.) The teats are thoroughly washed before each milking."

After receiving the above details concerning the making of the cream, the following experiment was made :—

July 8th.—To 1 quart of night's milk a piece of the solid portion of the Lawton cream, about the size of a filbert, was added. This residue had been left on the filter-paper ever since the analysis of the poisonous cream, June 14th, and it was on June 8th when the first milk for the preparation of the Lawson cream was collected. This dried and hardened lump was crumbled into the milk, which was placed in a clean tin pan and set in a cool cellar. July 9th.—To a quart of morning's milk, another small bit of the infected material was added, and this milk was also placed in the cellar. At 1 p.m. both portions of milk were poured into a clean earthenware jar, and four fresh eggs beaten, and 1 pint of granulated sugar were added. The whole was thoroughly agitated, then allowed to stand at the temperature of the room until 4 p.m., when it was placed in the ice-box of a refrigerator, surrounded by ice, and here kept until 7 a.m. the next morning, July 10th. Then 3 ounces of the custard were stirred up with distilled water, filtered, the filtrate rendered alkaline and agitated with ether. The residue, on the evaporation of the ether, was dissolved in a little water and given to a kitten about two months old. Immediately the kitten manifested the symptoms of poisoning by tyrotoxicon, which have already been described. I began the analysis of this custard in the morning before having my breakfast, and getting a little on my finger, in carrying the jar, I tasted of it. Within

a very few minutes I was nauseated, and ten minutes after taking it I vomited. The prompt action of so small a quantity was probably due to the condition of my stomach. At 2 p.m. of the same day I took one teaspoonful of the custard. Within thirty minutes there was marked nausea and some violent retching, but no vomiting. At 3 p.m. the symptoms having abated, I took a tablespoonful more of the custard. At about 3.30 I began to vomit freely. The nausea continued for about an hour. After this there would be passing sensations of sickness. At 8 p.m., while visiting a patient, I was taken very suddenly and sharply with nausea and griping pains in the abdomen. I again vomited, and had one watery stool. After this there was no further trouble. The occipital headache, mentioned by Dr. Moffitt in his letter, was very marked for some hours after taking the custard. It consisted of sharp lancinating pains, which were confined wholly to the occiput. The nausea was peculiar. I cannot say that there was pain in the stomach. A sickening taste would be felt in the mouth, and a peculiar very sickening odour—which I recognised as that of the isolated poison—would intensify the nausea. The throat and mouth seemed filled with a sticky tenacious mucus. In short, the effects on these parts resembled those which I have experienced from an over-dose of atropia.

I think that this experiment explains the poisonous nature of the vanilla cream. The fermentation going on in the custard, and probably begun in the milk, was arrested in that part flavoured with lemon by the freezing which began immediately, But while the lemon cream was being frozen, that part of the custard which was to be made into vanilla cream continued to ferment, and before the freezing process was begun enough of the poison was generated to seriously affect those eating of it.

The maker of the cream does not give us any exact information concerning the length of time which elapsed between the making of the custard and the freezing of that portion of it flavoured with vanilla. He only states that the lemon cream was frozen first. Recently I have received from Lawton a letter giving me more exact information on this point, also some valuable knowledge concerning the conditions under which the cream stood. I take from this letter the following extract:—"The cream was frozen in the back end of an old wooden building on Main Street. It is surrounded by shade, has no underpinning, and the sills have settled into the ground. There are no eave-troughs, and all the water falling from the roof runs under the building, the streets on two sides having been raised since the building of the house. The building had been unoccupied for a number of months, consequently has had no ventilation, and, what is worse, the back end (where the cream was frozen) was last used as a meat market. The cream which was affected was that portion last frozen; consequently it stood in an atmosphere more like that of a privy vault for upwards of an hour and a half or two hours before being frozen. It seems to me that anything so sensitive to surroundings as milk could not escape being affected by such an atmosphere."

The above, from a non-professional but evidently a very sensible observer, furnishes information of great value.

It should be remarked that in the custard which I made there was nothing peculiar in the taste. It was sweet and pleasant. But while it was not at all acid to the taste, it gave a decidedly acid reaction as tested by litmus, and was not amphoteric in reaction, as cow's milk frequently is.

It is possible that the presence of the large amount of albumen in the custard, from the eggs, hastened the fermentation. I believe that makers of cheese have found by experience that a large amount of albumen in cheese renders decomposition more easy.

How the special germ which produces the poison found its way into the Lawton cream I cannot say, but that it was either present in the milk or was contained in the eggs used I think cannot now be doubted.

The discussion of the possible relation between tyrotoxicon and cholera infantum will be omitted here, as it would not be suited to a chemical journal.

Note.—Since the above article was read at Buffalo tyrotoxicon has been found in milk by Drs. W. K. Newton and Shippen Wallace of New Jersey (see *Philadelphia Medical News*, Sept. 25, 1886), and by Prof. Sherver, chemist to the Iowa State Board of Health.—*Journal of Analytical Chemistry*, Vol. i., p. 24.

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT.

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(Continued from p. 42).

The solids extracted by petroleum spirit from the four parts of the plant are identified as fixed oils;* associated with a volatile principle (0·2 per cent) in *extract* (2), and with traces of chlorophyll in *extract* (3).

Fixed oil (1) was crystalline in structure. It was soluble in ether, chloroform, benzol, carbon disulphide, and amyl alcohol; incompletely soluble in cold or boiling alcohol, acetic ether, and ammonium hydrate. It was coloured pale green by sulphuric acid of 1·634 specific gravity, and changed to a bright-green colour by calcium disulphide, but formed no emulsion with it. Phosphoric acid coloured it yellow. The fixed oil was saponified, and a white soap separated. This was decomposed, and the fatty acids recovered. Glycerin was separated from the soap filtrate.

Fixed oil (2) was dissolved with difficulty in boiling 95 per cent alcohol, and hardened and discoloured by absolute alcohol. It was not saponified. Crystalline solids were separated by precipitating the alcoholic solution with magnesium acetate. They melted at 85° C., and at 60° C., respectively.

Fixed oil (3) was soluble in alcohol, ether, chloroform, benzol, carbon disulphide, oil of turpentine, almond oil, glycerin, and slowly soluble in acetic ether. The presence of free fatty acids was demonstrated. The fixed oil was coloured dark green by syrupy antimony chloride; on adding to it sulphuric acid of 1·475 specific gravity, and a small quantity of zinc, hydrogen was generated, and the solubility of the oil in the acid liquid was accompanied by a rosy tint given to the solution.

Fixed oil (4) was crystalline in structure. It was soluble in warm absolute alcohol, in cold acetic ether, chloroform, benzol, amyl alcohol, ether, carbon disulphide, and glycerin. It was saponified, and a white soap separated. The fixed oil was coloured dark brown by alcoholic ammonia, and a mixture of ferric chloride solution and powdered rosaniline gave a violet-coloured reaction with it.

These fixed oils differed in their physical characters and chemical reactions. This difference may be due to the presence of free fatty acids and glycerides in varying proportions in the four parts of the plant. It is of interest to note that in the subterranean part of the *Yucca*, the oil extracted from the bark was solid at the ordinary temperature; from the wood it was of a less solid consistency while the yellow base of the leaf contained an oil quite soft, and in the green leaf the oil was almost fluid.

Extract (2) contained an oil of low melting point. It melted at 36° C. An alcoholic solution was fractionally precipitated with magnesium acetate, and three members of the fatty acid series were isolated. The quantities obtained were small, and it was impossible to do more than to take the melting point of two of the purified

* Fixed Oils. *Science*, Sept. 11, 1885.

Summary I.—*Petroleum Spirit Extracts.*

	Solids extracted.	Character of residue.	Reaction with litmus.	Melting point.	Solidifying point.
1. The bark of the root ..	1·24 per cent.	Fixed oil.	Slightly acid.	60° C.	Solid at ordinary temperature.
2. ,, wood ,, ..	0·55 ,,	,, ,,	Neutral.	36° C.	
3. ,, green leaf	2·20 ,,	,, ,, Chlorophyll.	Acid.	Semi-fluid at ordinary temperature.	15° C.
4. ,, yellow base of leaf.	1·10 ,,	Fixed oil.	Faintly acid.		12° C.

crystalline residues. They melted at 85° C. and at 60° C. respectively. It is a well-known fact that a mixture of fat acids in certain proportions has a lower melting point than those of its constituents.

Alkaloids and volatile-alkaloids were not detected in the *petroleum spirit extracts.*

Ether Extracts.

Extract (1), *Bark of the Root.*

The residual powder from the petroleum spirit extraction was dried until thoroughly freed from petroleum spirit. It was then macerated with Squibbs's stronger ether in the apparatus already described. The *ethereal extract* was filtered from the powder. It was a clear crimson-coloured liquid, tinted by some red colouring matter dissolved, and acid in reaction. The *extract* was slowly evaporated at the ordinary temperature; white needle-shaped crystals were seen as the liquid concentrated. The *ethereal residue* was of a resinous character. It was ruby-coloured, transparent, and of a softer consistency than ordinary resin. Microscopically, the *residue* was identified as a resin by its colour reaction with Hanstein's aniline violet solution.* The *ethereal residue* was treated with petroleum spirit to remove any traces of fat that may have been extracted with it. It was heated in a small tube, at 50° C. it experienced a slight change, and melted at 70° C. For a determination of the total solids, a definite volume of the *ethereal extract* was evaporated, dried, and weighed.

Total Solids.

	Per cent.
Ethereal residue dried at 100° C...	3·16 of solids.
,, ,, ,, 110° C...	3·16 ,,
	0·00 of loss.

The resin was incompletely soluble in 95 per cent alcohol, absolute alcohol, and amyl alcohol; readily soluble in ether; not appreciably soluble in chloroform, benzol, and carbon disulphide. It was dissolved by sulphuric acid to a colourless solution, which, on warming, turned to a yellow colour, and gradually darkened to a dull brown colour, fading to a pale yellow.

An attempt was made to separate the white needle-shaped crystals mentioned above. The *ethereal residue* was agitated with acetic ether. The liquid was filtered from the insoluble matter and evaporated. Traces of a resinous substance were separated. The insoluble matter was treated with boiling ether, filtered hot, and the filtrate concentrated. On cooling, the white needle-shaped crystals reappeared. They were insoluble in water and in acetic ether.

A separate portion of the *ethereal extract* was evaporated, and treated with warm distilled water. The aqueous extract was made up to a definite volume, and a known quantity evaporated, dried, and weighed. The amount of total solids was almost inappreciable by weight. The aqueous extract was not coloured by iron salts, and it did not form a precipitate with alum and gelatin solution, lead acetate, potassio-mercuric iodide, nor gold chloride solutions; showing absence of tannin, gallic acid, and alkaloids. The *ethereal* extract was directly tested for these compounds, and with negative results. A portion of the aqueous extract was evaporated to dryness, and treated with potassa solution, and the residue dissolved with no colouration. Another portion of the aqueous extract was agitated with acetic-ether, and the liquids were separated; on evaporating the acetic ether solution, traces of a residue were obtained which sulphuric acid acted upon. A resinous substance separated from the greenish-coloured acid liquid; the former was partially disintegrated by cold water.

The specific gravity of the resin was 1·091.

Extract (2), *the Wood of the Root.*

The residual powder from the petroleum spirit extraction was macerated in stronger ether. The *ethereal extract* was of a reddish-yellow colour, slightly acid in reaction. It was slowly evaporated at the ordinary temperature, and as the liquid concentrated, white needle-shaped crystals appeared, and presented the same physical structure as the crystals found in the *ether extract* (1).

The *ethereal residue* was identified as a resin. It was a transparent, ruby-coloured substance, and acid in reaction. It was heated to 50° C., at that temperature its colour deepened, and at 70° C. it melted. The specific gravity of the resin was 1·091. A definite volume of the *ether extract* was evaporated, dried, and weighed to determine the amount of total solids.

Total Solids.

	Per cent.
Ethereal residue dried at 100° C.	1·70 of solids
,, ,, ,, 110° C.	1·45 ,,
	0·25 of loss.

The resin was examined by Hirschsohn's scheme* with a view to classify it with known resins. It was imperfectly soluble in 95 per cent alcohol and chloroform; soluble in ether. The alcoholic solution gave a turbidity with lead acetate, not cleared upon boiling, and with ferric chloride formed a clear mixture. Concentrated sulphuric acid dissolved the resin, leaving a dark yellow-brown liquid which faded to a dull yellow colour. The sulphuric acid solution, when mixed with alcohol, changed to a pale grey colour. On addition of water to the acid solution, there was no colouration nor separation of the resin. Alcohol containing hydrochloric acid gave no colour reaction with the resin. Bromine solution added to the chloroform-resin extract, and iodine solution to the ether-petroleum-resin extract, gave no reactions. Sodium carbonate at the ordinary temperature had no effect on the resin, but on boiling the liquid was coloured yellow.

By the above examination, this resin was thown out of the numerous classes of described resins. It is proposed to name it yuccal.†

Yuccal was soluble in boiling absolute alcohol and acetic ether; incompletely soluble in benzol, carbon disulphide, alcoholic ammonia, and cold acetic ether. The red colour of the resin was removed by cold acetic ether, a transparent substance remaining, soluble in hot acetic ether.‡ Yuccal was dissolved by potassio-mercuric iodide.

* "Botanical Micro-Chemistry.' Poulsen-Trelease. Boston, 1884 p. 59.

* E. Hirschsohn, "Watts's Chem. Dic.," vol. viii., Pt. ii., p. 1743.

† I suggest that in future all resins be distinguished by the terminal syllable *al*, for uniformity of resin nomenclature. Yuccal; *Science*, September 11, 1885, p. 210.

‡ I have examined the action of acetic ether as a solvent for resins. Cold acetic ether dissolved ordinary resin, turpentine, styrax, tolu-balsam, mastic, elemi, Canada-balsam, Peru-balsam, copaiba-balsam, Venice-turpentine, and incompletely spruce-gum, and yuccal. In hot

It reduced aqueous solutions of gold and platinum chlorides. A blood-red colour reaction was obtained by warming a small quantity of the resin on a crucible lid with a crystal of ammonium molybdate and a few drops of nitric acid. On adding to the resin mixture a few drops of strong sulphuric acid, and again warming, it was dissolved. Warm dilute nitric acid dissolved the resin, colourless; cold nitric acid gave a brownish-green colour reaction.* Yuccal was heated on platinum foil, and as it decomposed the fumes that were given off were pleasant and aromatic. Tests failed to show the presence of benzoic or cinnamic acids.

The *ethereal residue* was treated with warm water, and on cooling, the liquid was agitated with acetic ether, which was separated, and when evaporated yielded a small quantity of resinous substance. The *ethereal residue* insoluble in water was treated with boiling ether, and as the liquid concentrated, the white needle-shaped crystals were seen floating in it, but on further concentration they could not be seen, and a yellow greasy-looking mass settled in the bottom of the beaker. On driving off the ether, a transparent and ruby-coloured resinous substance remained. The aqueous extract obtained in the way described above gave no colouration with iron salts, and no precipitate with gelatin and alum solution, potassio-mercuric iodide, or gold chloride solutions. Fehling's solution was not reduced by boiling, though the aqueous extract was boiled with acid, then rendered alkaline before adding the copper test. The preceding tests gave negative results for gallic acid, tannin, alkaloids, and glucosides. A portion of the aqueous extract was acidified and agitated successively with different solvents, for glucosides, bitter principles, and alkaloids which may be removed from solution by this means. The acid liquid was then rendered alkaline with ammonia, and agitated successively with the same order of solvents that were used with the acidified liquid. No solids were separated by these methods. The *ethereal residue* insoluble in water was treated with alcohol; and yielded traces of a resinous substance. The residue insoluble in water and alcohol was not dissolved by ether, acids, or alkalies.

Yuccal, or the *ethereal residue* soluble in ether and alcohol, was saponified, and the soap boiled with lead acetate. The yellow masses were collected on a filter and treated with boiling ether, and the filtrate was slowly evaporated. The residue was a granular solid. This substance was imperfectly purified by repeated boiling with ether, and a solid of crystalline structure obtained. It gave an acid reaction with litmus, and a red colour with concentrated sulphuric acid. The acid dissolved a substance enclosing the crystals, leaving the structure of the latter uninjured and coloured. Strong nitric acid dissolved the crystals with no colouration. They were soluble in absolute alcohol, amyl alcohol, benzol, chloroform, glycerin, and a solution of alcoholic soda; soluble in potassium iodide, potassium chromate, mercurous nitrate, cobalt nitrate, potassium ferro- and ferri-cyanide solutions; insoluble in ammonia and aqueous alkalies.

Yuccal was treated with spirit of different strengths, as a means of separating resin acids if any were present. It was treated with 85 per cent spirit; an opaque brown substance was left undissolved, which was soluble in absolute alcohol, insoluble in ether, and coloured brown by concentrated sulphuric acid. The colour was not discharged by alcohol or ether. The 85 per cent spirit solution was evaporated, and the residue treated with 50 per cent spirit and a small quantity of a brown residue was insoluble. The 50 per cent spirit solution on evaporating left a non-crystalline, transparent, reddish-coloured solid, acid to litmus. It was coloured cherry-red by concentrated sulphuric acid, and slowly dissolved to a yellowish-red liquid.

(To be continued).

acetic ether spruce-gum and yuccal were soluble. The following resins were insoluble in hot or cold acetic ether, guiacum, sandarac, shellac, benzoin, olibanum, ammoniac, myrrh, galbanum, and asafœtida.

* A reddish-yellow decomposition product resulted from the action of nitric acid on many resins which followed generally quite soon after adding the acid to a small quantity of the resin (0·1 grm. of the resin and 5 c.c. of nitric acid 1·4 sp. gr.). But the reaction which took place varied according to the conditions, *i.e.*, strength of acid used, the application of heat to the resin acid mixture, or the addition of solvents to the mixture. The more concentrated the acid the more rapid was the reaction. The application of heat also hastened the change, especially if a more dilute acid was used in the mixture. Some solvents acted like heat by increasing the energy of the reactions. Alcohol and ether were active solvents, and the reaction was attended by the escape of nitrous fumes from the combination of alcohol or ether and nitric acid. Chloroform and benzol were indifferent. Amyl alcohol acted feebly.

NOTICES OF BOOKS.

"*Creation*," "*Supplement to Creation*," and "*Constitution of Matter*." By WILLIAM ANDREW. Providence, U.S.A.: Angell and Co., J. A. and R. A. Reid. 1886.

THE theory of the creation, constitution, and attributes of matter and force, as set forth in these three pamphlets, is in many respects a most remarkable one. There is a good deal in it which invites serious consideration, but at the same time there are some points to which we must take exception as being opposed not only to generally accepted hypotheses, but also to observed facts.

At the commencement we read, "Space, matter, motion, and may be others, are Nature, or the elements that compose all Nature. . . . An element of Nature is infinite in time and space, and it can neither be created or uncreated; and it has always been what it is now, and must always be what it is. . . . Matter has always been matter; it cannot be made from anything else, and matter is wherever space is; it has always had the same nature as it has now." These are curious statements. Matter, as we now know it, has very probably changed its nature in every respect. If the modern theory of the Genesis of Elements be a true one,—and it is based on very firm grounds,—the nature of all matter has changed from its original unatomic, unchemical, and unelectrical condition to that in which it now exists. If ether exists and is matter, it is certainly of a different nature to any matter we know.

Mr. Andrew then goes on to explain his theory of the universe, and he gives very great prominence to elementary motion, which is the motion an atom possesses to carry it through space irrespective of neighbouring and surrounding objects. This motion is very different from the popular conception of motion: we say a body is at rest if it is not moving in relation to the earth, while at the same time it may be moving through ether with enormous velocity. With respect to ether, atoms on the earth do not vibrate equally. Thus an atom is vibrating in itself in every direction, but the earth is rushing through space (or ether) at over 1000 miles per minute; therefore the vibrations of all atoms in ether are shorter in one direction than in any other. If the earth were really to come to rest the character of these vibrations would necessarily change, but with what effect it is not worth while considering.

A point worthy of attention is this: some people think, as Mr. Andrew tells us, that as time goes on the motion of the heavenly bodies will decrease, and their temperature will diminish, until nothing remains but a dead frozen mass in the centre of space; but he asks, how can infinite space have a centre? one point is as much a centre as any other.

From this we might argue back that as the necessary conclusion to the universe cannot exist, may not the other points in the argument be erroneous? No energy can be wasted, so, although we are continually losing heat by radiation into space, it will one day be reflected back again to us from those bodies which are now receiving it.

"There is a principle in Nature which I call certainty." This statement is explained as follows:—If we plant an acorn we are certain that, if anything grows from it, it will be an oak, not a pine, or a geranium, or a horse: there are, however, with us many things which we consider as uncertain,—for example, the weather,—but on reflection we can only admit that the apparent uncertainty is due to our want of knowledge. If our minds were infinite there would be no such thing as chance or mystery, but we should be able, by knowing all the causes, to predict all the effects in Nature.

The New Religio-Medici. Chapters on Every-day Subjects. By FREDERICK ROBINSON, M.D. London: Elliot Stock. 1887.

THE chapters in this book may be considered more as Essays on somewhat kindred subjects than as the gradual exposition of any particular views on any one subject as a whole. Some of them are in part reprinted, with alterations and additions, from the *Churchman* magazine, where they originally appeared.

Despite the semi-medical title of the work, there is really little which can be legitimately considered as requiring notice in a journal such as the CHEMICAL NEWS, but at the same time there are some portions which attract our attention—notably the chapter on "Faith Healing."

We must confess to some surprise when we read that "The supporters of this doctrine, there is reason to believe, are increasing in numbers." Such a doctrine, founded on a "single isolated apostolic utterance" and resting almost entirely on superstition and coincidence, would be more likely, we think, to be dying out in these days than to making material headway.

We acknowledge unhesitatingly that the condition of the mind of a patient must have very great influence on the success or non-success of any particular medical treatment. People may often worry themselves into illness, and, on the other hand, some can throw off an apparently severe indisposition with very little difficulty; but at the same time, when a definite disease exists, Nature requires more than "faith" to keep up the strength of the body while *she* effects the cure.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 1, July 4, 1887.

Alteration experienced by Retort-carbon when it Serves as a Positive Electrode in the Decomposition of Acids.—MM. H. Debray and Pechard.—If we employ electrodes of retort-carbon in order to decompose acid solutions by means of a current, we remark that the positive electrode is disaggregated more or less rapidly, forming a very finely-divided powder. The authors think that this disaggregation is not a mechanical phenomenon, but results from a more or less profound alteration of the substance, and that the pulverulent product yielded by the carbon must approximate in composition to the residues of alloys which M. Debray has described in Nos. 23 and 24 of vol. civ. of the *Comptes Rendus*. This powder contains, in fact, oxygen, water, and even nitrogen if nitric acid has been submitted to electrolysis. These various substances combine with the carbon under the influence of the current, which confirms the part played by electricity in the formation of metallic residues. The total quantity of oxygen fixed by the carbon, which serves as an electrode in the decomposition of acids, may reach 9 or 10 per cent, whilst the quantity of water may reach 8 per cent.

Certain Double Phosphates of Thorium and Sodium or of Zirconium and Sodium.—L. Troost and L. Ouvrard.—Sodium metaphosphate yields with thoria and zirconia double phosphates, which have analogous compositions, recalling those given by the action of potassium metaphosphate under similar conditions. The double metaphosphates of thorium and sodium thus obtained are not isomorphs of the double phosphates of zirconium and sodium. Sodium pyrophosphate gives, with thoria, double phosphates which have neither the same crystalline form nor the same composition as those obtained with zirconia.

Fluorescences of Manganese and of Bismuth.—Lecoq de Boisbaudran.—This paper does not admit of useful abstraction.

Report on M. de Mondésir's Memoir on the Rapid Determination of Active Calcium Carbonate in Soils.—MM. Debray, Reiset, and Schlœsing.—The authors consider that the instrument and the method devised by M. de Mondésir will be of great value for practical purposes.

Racemic Camphol and its Derivatives.—Alb. Haller.—The facts which the author has observed lead him to consider the camphol of amber as a mixture of dextro- and lævo-camphols in which the former predominates.

Synthesis of Pilocarpine.—MM. Hardy and Calmels.—The synthesis of pilocarpine is obtained by setting out from β-pyridino-α-lactic acid. It consists of two stages: transformation of β-pyridino-α-lactic acid into pilocarpidine and conversion of the latter into pilocarpine. The authors have found experimentally that synthetic pilocarpine produces the same symptoms in animals as does the natural product.

Zeitschrift für Analytische Chemie.
Vol. xxvi., Part 1.

Determination of Ammonia in Arable Soils.—W. Knop.—The author first stirred up the soil in question with a saturated solution of borax, and then added chloride of soda mixed with bromine (3 to 4 grms. per litre) previously dissolved in a minimum of soda-lye. Soils, on agitation with an alkaline liquid, undergo a contraction in consequence of which too little nitrogen gas is obtained in the subsequent volumetric determination. Afterwards he employed a solution of sodium hypobromite poured into a solution of borax mixed with small quantities of ammonium chloride. This liquid, without any especial addition of caustic soda, decomposes the ammonia completely and does away with the errors arising from the contraction of the soil. The quantities of soil taken for analysis should not be too large, 100 grms. being the preferable amount. The agitation of the sample with the decomposing liquid should not be prolonged.

Application of Oxalic Acid for the Separation of different Metals from others in Qualitative and Quantitative Analysis.—C. Luckow.—Already inserted.

Separation of Mercury and Palladium from each other and from Lead, Copper, and Bismuth.—Th. Rosenbladt.—Already inserted.

Quantitative Determination of Boric Acid.—Th. Rosenbladt.—Already inserted.

Iodometric Determination of Zinc and Cadmium Sulphides.—P. von Berg.—The author proceeds as follows:—The zinc sulphide, washed with water containing sulphuretted hydrogen, is drained and rinsed into a stoppered bottle from which the air has been expelled by a current of carbonic acid, and which has been charged with about 800 c.c. of recently boiled water (allowed first to cool in a stoppered vessel). The filter is also introduced, and the whole well and repeatedly shaken. Thus, the precipitate became suspended in the water in a state of minute and uniform division. Hydrochloric acid of moderate strength is next added, the liquids are mixed

by shaking, and a standard solution of iodine is added with a pipette. The completion of the reaction can be recognised by the permanent colouration of the liquid. The free iodine is then immediately determined with sodium thiosulphate. The solutions of iodine and of thiosulphate are standardised by means of potassium dichromate. This method is applicable also to cadmium, but not to cobalt, nickel, and manganese.

New Reaction of the Hyposulphites.— Prof. L. L. de Koninck.—If the alkaline hyposulphites are treated with aluminium in presence of potassium or sodium hydroxide they yield alkaline sulphites, which may be detected in the solution by means, *e.g.*, of sodium nitroprusside.

Detection of Ammonia, Nitrous or Nitric Acid, and Hyposulphurous Acid in a Mixture of Alkaline Salts.—Prof. L. L. de Koninck.—The aqueous solution of the saline mixture is introduced into a small fractionation flask, the steam delivery tube of which is bent vertically downwards, and opens into a U-tube containing a few drops of Nessler reagent. Some soda lye is then introduced into the flask, the neck is stoppered, and the contents are heated to a boil. As soon as the first drops have passed over it may be seen by the behaviour of the Nessler reagent whether ammonia was present in the solution. The distillation is continued until all the ammonia has passed over, the liquid is let cool, a few clippings of aluminium foil are introduced, and after a short time the liquid is again heated to a boil. If nitrous or nitric acid has been present it is reduced to ammonia, which can again be detected by means of a fresh portion of Nessler reagent. In the residue sodium sulphite is sought for; its presence proves that a hyposulphite was originally present.

Determination of Fatty Acids in Soaps.— Dr. B. Schulze.—The weighed samples of soaps are placed in small Erlenmeyer flasks, decomposed by dilute sulphuric acid, and the liberated fatty acids are dissolved by ether poured in so as to form a stratum above the acid. When the soap is completely decomposed the lower aqueous acid liquid is drawn off as completely as possible by means of a pipette, cautiously introduced; distilled water is added, shaken a little, and again drawn off, repeating this operation twice more. If, in this process, a little of the ethereal solution enters the pipette (which will not occur if sufficient care is taken) the complete withdrawal is rendered rather more difficult, since the vapours of the ether tend to force back the liquid out of the pipette, but it may be effected in the end, and losses of fatty acids need not be feared. When the aqueous solution has been for the fourth time removed down to a few drops the pipette is washed within and without with ether and one or two drops of barium chloride are let fall into the flask. By a little shaking all the sulphuric acid still present is precipitated, and with care little water is left below the ethereal solution, so that the latter may be at once poured upon the filter and treated as usual in determinations of fatty matters.

Contributions to the Analysis of Butters.— F. W. A. Woll.—A comparison of the results obtained by different analytical methods.

Detection and Determination of Lactic Acid in Physiological and Pathological Cases.—R. Palm.—The comminuted substance is exhausted with ether, which dissolves only lactic acid, fats, and possibly colouring-matters. The ethereal extract is evaporated on the water-bath to the consistence of oil, the residue is dissolved in water, leaving behind the fat, and the filtered aqueous solution is mixed with basic lead acetate. If a precipitate is formed it is filtered off. The filtrate, if it does not already contain an excess of basic lead acetate, is mixed first with this reagent and then with alcoholic ammonia as long as a precipitate is perceptible, when, if lactic acid is present, lead lactate falls of the constant composition $3PbO,2(C_3H_6O_3)$.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Tobacco Analysis.—Will any of your correspondents state their experience of (1) Estimation of nicotine in tobacco; (2) Detection of glycerin in tobacco?—W. S.

The London Hospital and Medical College,
MILE END, E.

The SESSION 1887-88 will commence on Saturday, October 1st, 1887. The New Buildings which were opened by T.R.H. The Prince and Princess of Wales, on May 21st, afford more than double the accommodation which was provided formerly.

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THE CHEMICAL NEWS.

Vol. LVI. No. 1446.

ON A SHARP LINE SPECTRUM OF PHOSPHORESCENT ALUMINA.

By WILLIAM CROOKES, F.R.S., Pres. C.S.

Since the publication of my paper "On the Crimson Line of Phosphorescent Alumina,"* I have been working unremittingly on the subject, with the view of clearing up the differences existing between M Lecoq de Boisbaudran and myself in respect to the cause of the red phosphorescence of this earth.

It will be remembered that M. de Boisbaudran stated at the Académie des Sciences, in December last, that the presence of chromium was indispensable to the production of the red fluorescence of alumina; the $\frac{1}{100}$th and even the $\frac{1}{1100}$th part of chromic oxide being sufficient to give a brilliant red fluorescence as well as its special spectrum to alumina, whilst with the $\frac{1}{10000}$th part of chromic oxide a very visible rose-colour was still obtained.

In my paper above referred to I gave reasons for differing from the conclusions of the eminent French chemist. I explained how I purified alumina so as to secure its freedom from chromium; how I then tested this alumina and obtained its characteristic phosphorescence and spectrum; how I next mixed chromium with it in varying proportions without conferring on the alumina phosphorescence to any marked extent over what it had before the addition of chromium; and how then I fractionated my purified alumina by different methods, and found that the crimson-line forming body concentrated towards one end of the fractionations. Finally I suggested the following four possible explanations of the phenomena observed:—

"1. The crimson line is due to alumina, but it is capable of being suppressed by an accompanying earth which concentrates towards one end of the fractionations.

"2. The crimson line is not due to alumina, but is due to the presence of an accompanying earth concentrating towards the other end of the fractionations.

"3. The crimson line belongs to alumina, but its full development requires certain precautions to be observed in the time and intensity of ignition, degree of exhaustion, or its absolute freedom from alkaline and other bodies carried down by precipitated alumina, and difficult to remove by washing; experience not having yet shown which of these precautions are essential to the full development of the crimson line and which are unessential.

"4. The earth alumina is a compound molecule, one of its constituent molecules giving the crimson line. According to this hypothesis alumina would be analogous to yttria."

Experiments on the Purification of Alumina.

Little or nothing being known as to the delicacy of the methods of separating aluminium and chromium, it seemed a matter of first importance to experiment on this subject and endeavour to prepare an alumina which should represent the utmost attainable purity. A considerable quantity of commercial ammonia-alum was dissolved in water to a dilute solution, and caustic soda† added in sufficient quantity to re-dissolve nearly the whole of the precipitate. A little undissolved alumina, iron, &c., were left behind. The alkaline liquid was boiled for an hour and then filtered. On testing the precipitate a trace of chromium was detected.

The clear alkaline solution was saturated with chlorine gas till no more alumina fell down, and the liquor retained, after repeated agitation and rest, a strong chlorous odour. It was assumed that any chromium which might have escaped precipitation from the boiling soda solution would be oxidised and kept in solution as sodium chromate by the excess of chlorine. The precipitated alumina was filtered off, and well washed with hot water till chlorine was found to be absent from the washings.

This alumina was a second time dissolved in caustic soda, and the solution was well boiled. No precipitate came down. The clear solution was again submitted to the chlorine treatment, and the precipitated alumina was filtered and washed. A considerable quantity of alumina was prepared in this manner. It gave a good crimson line in its phosphorescent spectrum.

Separation of Alumina and Chromium.

It will be noticed that, in the above method of preparing alumina, I have assumed that the processes of separating alumina and chromium, (1) by boiling the alkaline solution and (2) by passing excess of chlorine through the alkaline solution, are accurate in the presence of an enormous excess of alumina. This, however, is an assumption which it is not safe to make, and accordingly I tried special experiments on each point.

1. *By Boiling the Alkaline Solution.*— Sulphate of alumina was mixed with standard solution of chrome alum in the proportion of 10,000 parts alumina and one part of chromic oxide. Caustic soda was added till the precipitate just re-dissolved, and the whole was boiled. A distinctly visible precipitate of a green colour came down. This was filtered, washed, and tested for chromium by fusion with nitre, &c. Every test showed chromium.

The same operation was repeated on a mixture containing one of chromic oxide and 50,000 of alumina. The results were equally conclusive. I have no doubt that, by this method, I could have separated a very much smaller quantity of chromium from alumina.

2. *By passing Chlorine through the Alkaline Solution.*—A mixture of sulphate of alumina and chrome alum in the proportion of 50,000 alumina to one of chromic oxide was mixed in the cold with excess of caustic soda, and the clear liquid supersaturated with chlorine gas and filtered. The filtrate from the alumina, which should contain all the chromium present in the form of sodium chromate, was supersaturated with hydrochloric acid and boiled till free from volatile chlorine compounds. Sodium sulphite was then added, and it was again boiled to reduce any chromic acid which might be present. Ammonia in excess was now added, and the whole was boiled; a very small precipitate fell down; it was filtered and washed. Chromium was easily detected in it by the usual tests, although the amount recovered was not so large as by process No. 1.

It may be objected that these methods are not so delicate as I suppose them to be—that a certain quantity of chromium always adheres to the alumina, and that when I add a trace more and then appear to recover it I do not recover that identical trace, but only that portion of the chromium which my addition has raised to the detection-point. This may be so; it is a rather unlikely phase of chemical reaction, but I do not see how it can be got over except by uniting several different methods of purification. Chemical analysis would scarcely deserve the name of a science if so strained an argument as the one above quoted were to be generally applicable.

3. *By Fractional Crystallisation of Ammonia-Alum.*—Ammonia-alum, found to be free from chromium by each of the above methods, was mixed with the 50,000th part of its weight of chrome alum and submitted to fractional

* *Roy. Soc. Proc.*, vol. xlii., pp. 25 to 31, Jan. 13, 1887; Chemical News, vol. lv., p. 25.

† Soda was used in preference to potash owing to the ease of getting the former alkali pure by oxidising metallic sodium.

crystallisation, the crystals from each dish being added to the mother-liquor from the crystals below them, the mixture re-dissolved and again allowed to crystallise.

In this way the crystals at each operation were lifted a step higher, whilst the mother-liquors were similarly degraded a step. Not many crystallisations were required to show which way the chromium travelled. The lowest mother-liquor gradually began to show colour, and after about thirty crystallisations abundance of chromium could be detected in the last mother-liquor, a considerably smaller quantity in the penultimate dish, and a trace in the antepenultimate. In crystals representing the higher fractions no chromium could be detected.

This method therefore proves that fractional crystallisation is as good a way as any for ridding alumina of traces of chromium, if, indeed, it is not the best way, inasmuch as the method is easily adopted on the large scale, whilst it is cumulative; for we cannot well apply to it the reasoning advanced against processes 1 and 2.

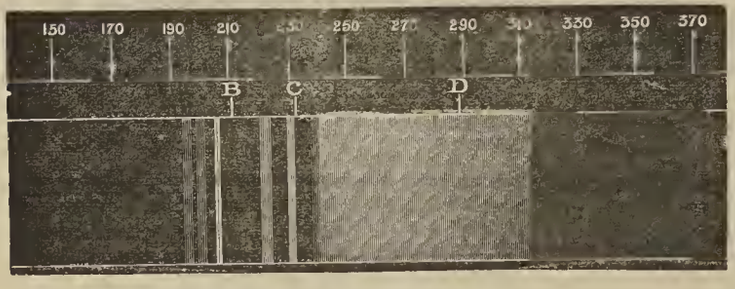
Preparation of Pure Alumina.

Alumina which had been doubly purified by processes 1 and 2 was converted into sulphate and mixed with the equivalent quantity of ammonium sulphate; re-distilled sulphuric acid and pure aqueous solution of ammonia being used. On evaporating the solution fine crystals of ammonia-alum were obtained. These were re-crystallised five times, dried, and kept as the stock material for future work.

Fractionation of Pure Alumina.

The ammonia-alum purified in the above manner* was now submitted to systematic fractionation by crystallisation in the way described above (process 3).† Tests in the radiant matter tube were from time to time taken with the products of each dish; a small quantity of the solution being removed and, after ignition of the contained alumina to a white heat, submitted to the induction spark in a high vacuum. At first the spectrum of the phosphorescent light was similar to the one already described,‡ consisting essentially of a sharp crimson double line, then a pair of fainter and rather nebulous red lines, and beyond these a continuous spectrum extending from red to green.

Fig. 1.



The Alumina Spectrum.

The accompanying cut (Fig. 1), borrowed from the paper already quoted, gives a fairly accurate representation of the spectrum, drawn to the $\frac{1}{\lambda^2}$ scale. The continuous portion of the spectrum is, however, shown a little too strong.

As fractionation proceeded the character of the phosphorescent spectrum given by the higher crystals underwent a remarkable modification. The continuous spectrum extending from about 236 to about 310 became fainter, and beneath it a system of sharp lines were visible. Further fractionation had the effect of lifting the continuous light as a veil and disclosing beneath it the new lines in greater and greater strength and sharpness, until finally they stood out with almost gas-like sharpness on a black background. As the continuous spectrum disappeared the crimson line at 20765 became fainter, as if continued fractionation would separate it from the new lines, but I have only once, almost by accident, succeeded in effecting this.

Approximate measurements of this new spectrum are given in the following table:—

Scale of spectroscope.	$\frac{1}{\lambda^2}$	Remarks.
10·220	2562	Centre of faint hazy band.
10·185	2613	Strong line.
10·140	2678	Less strong line.
10·04	2820	Faint line.
10·00	2877	Faint line.
9·935	2970	Stronger.
9·87	3061	Faint green, sharper on the edge nearest the blue.
9·8	3160	Centre of broad green band.
9·69	3312	Do. Do.
9·545	3506	Limiting edges of a nebulous green band.
9·5	3570	
9·07	4130	Centre of a band similar to last, but broader and more hazy.

Towards the lower end of the fractionations the spectrum of the phosphorescent alumina gave the crimson line, the faint red lines, and the continuous spectrum with great brilliancy. I have shown that when chromium is present it concentrates at the lower end, and it is toward this end that the old alumina spectrum is seen in greatest perfection. This is a strong argument in favour of M. de Boisbaudran's view that the red phosphorescence and crimson line are caused by the presence of traces of chromium in the alumina, and against my contention that alumina free from chromium gives the same appearance. On the other hand chemists will bear in mind the excessive precautions I took to secure absence of chromium; and it must also be remembered that when chromium was intentionally added it was readily removed by a few fractional crystallisations, being undetected in the fourth lowest dish. Here, however, my presumably chromium-free alum showed the crimson line in almost the highest dish after a hundred fractionations, whilst even the lowest dish did not contain a detectable trace of chromium.

But, whatever be the active agent in producing the crimson line spectrum, it is evident that the new line spectrum cannot be due to chromium; and before chemists acquiesce in M. de Boisbaudran's view, that chromium and not alumina produces the crimson line spectrum, the presence of chromium must be demonstrated in my high aluminas by an analytical test vastly more delicate than any which is now known to me.

I willingly admit that M. de Boisbaudran has shown that a little chromium acts as an intensifier to the old alumina spectrum, just as lime and other earths act towards the spectrum of samaria, and it is an important point gained in this difficult branch of spectroscopy. But my learned friend's contention is that the chromium is the active body ("matière active") and the alumina is merely a solid solvent ("dissolvant solide") or diluent. Were this the case alumina by itself should be incapable of giving the crimson line spectrum, whilst chromium should yield this spectrum when mixed with other solid solvents.

I think I have sufficiently proved that alumina without chromium gives the crimson line, and it remains therefore to be ascertained what is the effect of adding a little chromium to other solid solvents. Were the crimson line a chromium one it is not likely that alumina should be the only solid solvent for chromium capable of developing it. With samaria, for instance, we know that not only lime, but baryta, strontia, glucina, thoria, lanthana, magnesia, alumina, zinc, cadmium, lead, and other metallic sulphates bring out the characteristic samarium spectrum.

* To avoid periphrasis I shall in future call this *pure alum*.

† For brevity I will call the crystals end the *higher end*, and the mother-liquors the *lower end* of the fractionation.

‡ *Loc. cit.*, Fig. 1.

M. de Boisbaudron has examined the effect of adding chromium to oxide of gallium.* He now finds the spectrum to consist of a sharp red line and a wide nebulous band. The red line is sufficiently faint for it to have been altogether missed by its discoverer when the announcement of the Ga and Cr spectrum was made in February,† so it cannot be called a very strong line. The wave-length is given as about 6897 to 6898 $\left(=\frac{I}{\lambda^2}\ 2102\right)$, a point on the spectrum close to the solar line B, and very far from the alumina crimson line which occurs at about—

$$\lambda\ 6940 = \frac{I}{\lambda^2}\ 2076.$$

Considering the close chemical analogy between aluminium and gallium it is not surprising that there is a distant resemblance between their two spectra.

For my part I have taken glucina, magnesia, lime, oxide of zinc, and other similar bodies, have added various proportions of chromic oxide to them, and have tried heating with and without sulphuric acid. The mixture has been raised to different temperatures from cherry-red to full white, and in no single case did I see any sharp red line. The general character of the phosphorescence was reddish orange, the spectrum being almost continuous, with the extreme red and blue ends obliterated. The amount cut off, and the relative intensities of the orange, yellow, and green portions, differed in each case, causing the superficial colour to vary.

Postscript, August 11th, 1887.

For some months past I have been quietly experimenting and writing the above paper with the intention of sending it to a scientific Society at the close of the vacation, when on Monday last, Aug. 9th, the *Comptes Rendus* of the sitting of the *Académie des Sciences* for Aug. 1 came to hand. In it I see that M. de Boisbaudran read a paper on some "New Fluorescences with Well Defined Spectral Rays." This leaves me no option but to publish instantly as far as I have written, and at the same time to give a brief account of some other results I have obtained—results which I had intended should form the basis of an additional paper.

M. de Boisbaudran prepares a mixture of alumina with 2 per cent of samaria and converts them into sulphates. After heating to a temperature between the melting-points of copper and silver, this mixture, in the radiant matter tube, gives a feeble fluorescence, the spectrum of which resembles the well-known samarium-aluminium spectrum, which I described in June, 1885.‡

I reproduce here the drawing of the aluminium-samarium spectrum which illustrated that paper.

After energetically calcining his aluminium-samarium mixture before the blowpipe, M. de Boisbaudran finds its spectroscopic appearance to entirely alter. Instead of consisting of three nebulous bands, it now consists of a number of sharp rays "which form three groups corresponding respectively to each of the above described three diffused bands, but being refrangible."

I have only had time to prepare a few mixtures of aluminium and samarium sulphates, and test their phosphorescent spectra after calcination at different temperatures. With 2 per cent of samaria, ignited at a low temperature, the phosphorescent spectrum is that of samaria slightly modified by the presence of alumina, as I described and figured it two years ago. After ignition at a white heat the samarium spectrum disappears, and is replaced by a sharp line spectrum as described by M. de Boisbaudran.

Contrary, however, to what this distinguished chemist says, I do not see between this spectrum and the one it has replaced any such resemblance which would enable me to assent to his opinion that the groups correspond, "except that those of the line spectra are less refrangible." In my opinion, as far as I can form one by careful scrutiny of the spectra without actual measurements, the new aluminium-samarium high temperature spectrum is very similar to that which I have described in the former part of this paper, as yielded by pure alumina after intense ignition.

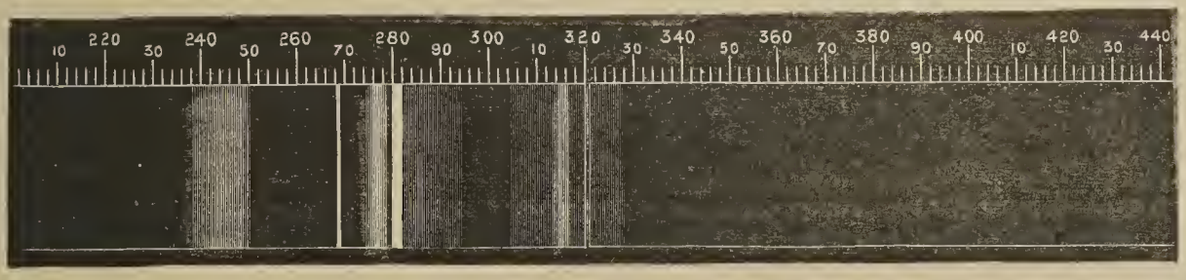
That this explanation is probable may be seen by the following argument. Both samarium sulphate* and aluminium sulphate will stand a red heat without the sulphuric acid being driven off. Aluminium sulphate does not phosphoresce, but samarium sulphate does. The mixture therefore gives the samarium spectrum.†

Now ignite the mixed sulphates to the highest blowpipe temperature. Both are decomposed, leaving a mixture of samaria and alumina. Samaria by itself gives practically no phosphorescent spectrum, but alumina ignited to a very high temperature gives the new line spectrum I have already described. The mixture, therefore, might reasonably be expected to give the line spectrum of alumina, and this is what comparison, in the absence of measurement, leads me to believe has occurred. I have scarcely had time to verify this by measurement in my large spectroscope, but next week I hope to publish drawings of the different spectra carefully mapped to scale, so that anyone will be able to form his own opinion of their concordance or disagreement.

It may be argued that the "pure" alum used for fractionation contained a little samarium. In my anxiety to keep out chromium I might have overlooked the former earth. I have, therefore, tried some experiments to see which way samarium travels during fractional crystallisation, if it happens to be present in alum.

Some of my pure alum was mixed with a very little impure samarium sulphate, and fractionally crystallised about fifteen times. Nearly the whole of the samarium (with accompanying didymium) concentrated in the lowest mother-liquor, the last dish but one containing scarcely any samarium, whilst none could be detected in any of the higher crystallisations either chemically or in the

Fig. 2.



* *Comptes Rendus*, vol. civ., p. 1584, June 6th, 1887.

† *Ibid.*, vol. civ., p. 333, February 7th, 1887.

‡ "Aluminium and samarium give a spectrum resembling the corresponding calcium one as to the red and double orange, but having a very broad, somewhat faint, green band, with a black division in the middle occupying the position of the bright green band of calcium-samarium."—"On Radiant Matter Spectroscopy. Part II.—Samarium. By William Crookes, F.R.S., V.P.C.S. Read before the Royal Society, June 18, 1885. *Phil. Trans.*, 1885, Part 2, p. 712.

On Radiant Matter Spectroscopy. Part 2,—Samarium." *Loc. cit.*, par. 137.

† *Loc. cit.*, par. 144.

radiant matter tube. As the new line spectrum of alumina is best seen with the crystals at the higher end, whilst samarium rapidly settles to the lowest end, it is evident that a far less number than the hundred fractionations actually effected would remove the uttermost trace of samarium from that fraction of alumina which gave the line spectrum.

ON SHARP LINE SPECTRA OF PHOSPHORESCENT YTTRIA AND LANTHANA.

By WILLIAM CROOKES, F.R.S., Pres. C.S.

In a paper on Yttria published in 1883* I showed that pure yttria precipitated by ammonia from the sulphate, then dried at a temperature below redness and tested in the radiant-matter tube, did not phosphoresce in the slightest degree. The remarkable results which I have lately obtained with intensely ignited alumina induced me to examine the behaviour of other earths after being submitted to intense ignition.

Precipitated yttria ignited to a full white heat phosphoresces with great brilliancy with a clear yellow light, and gives in the radiant-matter tube a very beautiful spectrum of sharp lines. In the red there are two groups of lines, followed by a very prominent orange line at about $\frac{1}{\lambda^2}$ 255. Then come several fainter lines and an intensely brilliant citron line, occupying the position of the well-known citron band given by yttrium sulphate.† On examination with a very high power and narrow slit this is seen to be double, the two components being a very little closer than the D lines; indeed so closely does this citron line resemble that of sodium, that nothing short of seeing the two side by side in different parts of the same spectrum will convince anyone who sees the citron line for the first time that he is not looking at the sodium line. After the citron line comes a faint sage-green band and two brilliant groups of green lines. Then comes a comparatively clear dark space, and finally there is a wide blue band composed of numerous fine lines, and a similar bundle of fine lines in the violet.

A specimen of white lanthana prepared by myself some years ago, but of which the history is obscure, on being strongly calcined, became of a fawn colour. When examined in the radiant matter tube this earth phosphoresced of a superficial yellow colour, giving a remarkalby brilliant spectrum. In the red is a fine line very similar to the alumina line, quite sharp, but nearer the position of the C line of hydrogen. Next follow a hazy pair of red lines, the first of which appears compound; then come a nebulous pair of green lines, and lastly another widely separated pair of a bluish green colour, the first of which is of extreme brilliancy.

Treated in the same manner samaria, ytterbia, erbia, and niobic acid have given no striking results; but the research is in too premature a state to permit me to say more in this hurried note.

The Alums formed by Selenic Acid.—C. Fabre.—The author has prepared the selenic aluminium alums of potassium, sodium, cæsium, rubidium, thallium, ammonium, ethylamine, diethylamine, triethylamine, methylamine, dimethylamine, and propylamine, all corresponding to the general formula $Al_2O_3,3SeO_3 + MOSeO_3 + 24HO$. A mixture of the *violet* solution of chromium seleniate gives well-crystallised alums with potassium, sodium, cæsium, rubidium, thallium, ammonium, ethylamine, and propylamine seleniates.—*Comptes Rendus*, Vol. cv., No. 2.

* The Bakerian Lecture, "On Radiant Matter Spectroscopy: The Detection and Wide Distribution of Yttrium." *Phil. Trans.*, 1883, Part 2, par. 75.

† *Loc. cit.*, pars. 71, 72

ON THE FORMATION OF NITRITES DURING NITRIFICATION OF AMMONIACAL SOLUTIONS.

By J. M. H. MUNRO, D.Sc.,
College of Agriculture, Downton, Salisbury.

In the great majority of the experiments on nitrification in artificial solutions which have been made and published by Warington* and by myself† in this country, and by various observers on the Continent, the earlier stages of the process are marked by the formation of a variable quantity of *nitrite*. So generally is this the case that, when observing the nitrification of ammonia added to well waters already containing nitrate, the production of the first recognisable trace of *nitrite* was always tested for by me to mark the commencement of the nitrification process.‡ It is true that in special cases complete oxidation of ammonia to nitrate may be observed without nitrite appearing at any stage of the process, and we can generally secure this result by attending to the conditions pointed out by Warington and confirmed in my own experiments. These are extreme dilution of the ammoniacal solution, low temperature, presence of the nitrifying ferment or seed in considerable quantity and active condition, shallow layers of liquid, and free admission of air. Nitrites (unless formed by reduction) are not often met with in natural waters, because these conditions of a purely nitric fermentation are generally present; they *are* almost always found in experiments with artificial solutions, because these conditions are not all present.§ In general the formation of nitrite begins after the period of quiescence or incubation which usually precedes nitrification, increases up to a certain period, and then *in most cases* the nitrite present diminishes by degrees as fast as it undergoes conversion into nitrate. Sometimes, however, the nitrite persists without alteration for months, and then may suddenly undergo rapid conversion into nitrate: the cause of this capricious behaviour is not known.

It has been generally held that the nitrite thus formed (whether by the agency of a special organism or by that which forms also nitrate) arises from direct but incomplete oxidation of the ammonia, and that it represents in fact a mere passing phase of the transformation of ammonia into nitrate.

But it has also been suggested that the nitrite may be formed by a secondary action, viz., reduction of the nitrate at first formed, instead of by oxidation of ammonia. Denitrification is a process very easily brought about under a great variety of circumstances, and by the agency of microbes of many different kinds, and it very often takes the form of reduction of the nitrate to nitrite as a first stage. The mere exposure to unfiltered air of a liquid containing at once fermentable organic matter and a nitrate is almost certain to be followed in a day or two by the appearance of nitrite formed by reduction.‖ Gayon and Dupetit have shown that the various microbes which have the power to effect this change do so by causing oxidation of the organic matter at the expense of the oxygen of the nitrate, when they multiply in liquids not freely exposed to the air. Hence the suggestion that the nitrifying organism itself, after developing at the bottom of a nitrifying solution, may acquire a character similar to that of the denitrifying bacteria, and may cause the nitrate which has already been formed under its agency to part with oxygen which either oxidises organic carbon or more ammonia to nitrite. In the former case all the nitrite would be produced by a secondary reduction of the nitrate; in the latter case, three-fourths

* *Chem. Soc. Journ. Trans.*, 1878, p. 44; 1879, p. 429; 1884, p. 637.
† *Ibid.*, 1886, p. 632.
‡ *Loc. cit.*, p. 663.
§ Munro, *loc. cit.*, p. 679.
‖ Gayon and Dupetit, in abstract in *Chem. Soc. Journ.*, 1886 (Abs.), p. 823; Munro, *loc. cit.*, p. 667, *et seq.*

by secondary reduction of nitrate, one-fourth by direct oxidation by ammonia.

Messrs. Gayon and Dupetit, who have suggested that the nitrite observed during nitrification is really formed by reduction of nitrate, leave it to be inferred that in this case the oxygen given up by the nitrate goes to oxidise organic matter which they assume to be present in the solution.* But if it be shown that the nitrite developed during nitrification is formed in the absence of oxidisable organic matter, then it is not produced by such a reduction of nitrate as that suggested by Gayon and Dupetit, as the work either of foreign organisms or of the modified nitrifying organism itself; and if also it be shown that ammonia is not oxidised by reduction of nitrate, then it will follow that the nitrite produced in nitrification is due to direct oxidation of ammonia by atmospheric oxygen. The first half of this statement has been demonstrated in my former paper;† the experiments which are now to be described were instituted last year in order to throw light on both points, but more especially the latter. If the nitrifying organism forms nitrite by direct oxidation of ammonia only, it is plain that no more nitrite can be formed than corresponds to the ammonia present; if, on the other hand, it has the power of reducing already-formed nitrate in order to oxidise the ammonia, producing nitrite from both, then if nitrification be carried on in a liquid to which nitrate has been purposely added, there is no reason why the nitrite produced should not exceed in quantity that producible from the ammonia present,—in fact it may be four times this quantity, if all the ammonia is oxidised at the expense of the nitrate, thus—

$$NH_3+3KNO_3=HNO_2+3KNO_2+H_2O.$$

A solution was therefore prepared, containing ammonium chloride with 3 equivalents of potassium nitrate, some calcium carbonate as salifiable base, and a little soil to supply the nitrifying organism; the quantity of nitrite formed in this was determined from time to time, in order to see whether it was at any time more than equivalent to the ammonia salt added.

A second solution, made up for comparison with this, resembled it in every respect save that the potassium nitrate was omitted.

A third solution contained the potassium nitrate and soil only, the object being to show that the nitrate was not reduced to nitrite by soil alone under the circumstances of the experiments.

Solution A contained 85 c.c. standard ammonium chloride (= 85 m.grms. NH_3 = 70 m.grms. N), 1·515 grms. potassium nitrate (= 210 m.grms. N), and 500 m.grms. calcium carbonate, made up to 700 c.c. with distilled water.

Solution B, the same, without the potassium nitrate.

Solution C, 1·515 grms. potassium nitrate in 700 c.c. distilled water.

The solutions were placed in three similar stoppered bottles, which they more than half filled, and a little soil from a recently nitrified solution was washed, divided into 3 parts, and added to each. The layer of liquid in each bottle was 5 inches deep. The solutions were made up on June 25th, 1886, and kept in the dark in a cupboard in the Laboratory. The conditions were very favourable to production of nitrite, since the solutions were strong, the quantity of seed small, and the air in the bottle could only be renewed when the stoppers were removed in order to test the liquids—not more than fifteen times in the course of twelve months.

The results of the periodical testings of these solutions are summarised in the following Table:—

Solution B.—NH_4Cl alone.

Date.	Interval.	5 c.c. tested with metaphenylen diamine gave	10 c.c. deco-lourised c.c. permanganate.	M.grms. N as nitrite in 700 c.c.
1886.				
June 25	—	No colour	Made up	0
,, 26	1 day	,,	—	—
,, 28	3 days	Faint straw yellow	—	—
July 1	6 ,,	Yellow	—	—
,, 5	10 ,,	Bright yellow	—	—
,, 15	20 ,,	Deep amber	0·5	3·06
,, 22	27 ,,	Very deep amber	1·35	8 27
,, 29	34 ,,	,,	1·85	11·33
Aug. 6	42 ,,	Red	2·25	13·78
,, 14	50 ,,	,,	3·70	22·66
Oct. 18	115 ,,	,,	10·40	63·70
Nov. 11	139 ,,	,,	10·70	65·53
Dec. 17	175 ,,	,,	10·00	61·25
1887.				
Mar. 7	255 ,,	No colour	None	None
June 24	364 ,,	,,	,,	,,

Solution A.—$NH_4Cl+3KNO_3$.

1886.				
June 25	—	No colour	—	0
,, 26	1 day	,,	—	—
,, 28	3 days	Straw-yellow	—	—
July 1	6 ,,	Bright yellow	—	—
,, 5	10 ,,	Deep yellow	—	—
,, 15	20 ,,	Deep amber	0·95	5·81
,, 22	27 ,,	Red	2·45	15·00
,, 29	34 ,,	,,	3·80	23·27
Aug. 6	42 ,,	,,	4·7	28·79
,, 14	50 ,,	,,	5·2	31·85
Oct. 18	115 ,,	,,	9·6	58·80
Nov. 11	139 ,,	,,	10·4	63·70
Dec. 17	175 ,,	,,	10·5	64·31
1887.				
Mar. 7	255 ,,	,,	8·7	53·28
June 24	364 ,,	No colour	None	None.

Of Solution C, which contained the potassium nitrate and soil only, it is sufficient to say that a trace of nitrite developed on the third day, and disappeared between the sixth and tenth days; during the remainder of the 364 days no trace of nitrite appeared. The trace of nitrite at first formed evidently arose from oxidation of the trace of ammonia contained in the distilled water (ordinary distilled water was used, giving at first a pale amber with Nessler's test, but no colour on the sixth day); it almost immediately passed into nitrate. It is evident that no formation of nitrite by reduction of nitrate took place in this solution throughout the experiment.

Solutions A and B, it will be seen, behaved almost alike. Nitrite began to be developed immediately, and gradually increased in quantity during four or five months after making up the solutions, when about 65 m.grms. out of the 70 m.grms. of N originally added as ammonium chloride appeared as nitrite. Tested at intervals with Nessler's solution, No. 1 was found to have lost nearly all its ammonia on October 18th, and No. 2 on November 11th; on March 7th both were free from ammonia. The nitrite persisted through the winter in both solutions, but suffered complete conversion into nitrate during the following spring. In both solutions, therefore, the ammonia was almost completely converted into nitrite before the commencement of the nitric fermentation, and the

* "Dans les recherches sur les variations des propriétés du ferment nitrique, M. Warington a vu se former de l'acide nitreux au sein de ses cultures, des que l'épaisseur de la couche liquide devenait un peu grande. Ou peut expliquer ce fait en admettant que l'oxydation par le même ferment nitrique a fait en deux périodes; dont la première donnerait précisément l'acide nitreux, ou en supposant, avec M. Duclaux, que deux ferments, l'un nitreux, l'autre nitrique, s'étaient développés simultanement. Nous pensons plus volontiers que les nitrites étaient dus, non à une oxydation partielle de la matière organique, mais à une désoxydation incomplète de l'acide nitrigue déjà forme, soit que le ferment nitrique de M. Warington ne fut pas pur, soit, ce qui est moins probable, qu'il eut acquis des propriétés reductrices, en vivant en profondeur, hors de l'oxygène de l'air."—*Recherches sur la Reduction des Nitrates par les infiniment petits*, pp. 4, 5, Gayon et Dupetit.

† *Loc. cit.*, p. 651, *et seq.*

nitrate purposely added to Solution A was apparently without influence on this conversion. At no time did the N as nitrite present in this solution exceed that originally added as ammonium chloride. It appears therefore that the ammonia was in both solutions oxidised to nitrite by oxygen obtained from the air, and that none of the nitrate added to Solution A was reduced to nitrite for the purpose of oxidising either ammonia or the small quantity of organic matter present in the soil. That the conditions of the experiment were favourable to nitrite formation is evident from the fact that nearly all the ammoniacal nitrogen was converted into nitrite before the formation of nitrate commenced.

It may be further noted that, whereas the oxidation of organic matter by oxygen disengaged during reduction of nitrate has been shown, both in theory and fact, by Gayon and Dupetit, to result in the evolution of heat, no such production of heat appears to warrant the possibility of nitrite formation by simultaneous reduction of nitrate and oxidation of ammonia. The equation already given indicates rather an absorption,—that is to say, much more heat is absorbed by the decomposition of a molecule of ammonia, and the reduction of three molecules of nitrate to nitrite, than is evolved by the formation of one molecule of water, and one molecule of nitrous acid, and the saturation of the latter by a base.

The conclusion arrived at is that nitrite is formed during the nitrification of ammoniacal solutions by direct oxidation of ammonia, and without any reduction of already-formed nitrate.

ON A MODIFICATION OF THE FERRIC CHLORIDE CELL.

By THOMAS MOORE.

The usual form of the ferric chloride cell consists of an amalgamated zinc plate or cylinder in dilute sulphuric acid, and a carbon in the porous cell, with a strong acid solution of ferric chloride as a depolariser. When first made up it yields a powerful current, but owing to the rapid reduction to ferrous chloride, and the comparatively slow absorption of oxygen, the strength rapidly decreases. Mr. Warren has, however, made an immense improvement on this by using bromine with the ferric chloride. But the use of bromine is rather expensive; for although it is possible to recover it by the addition of a little bleaching-powder, still there is always a considerable loss, and the operation is rather disagreeable. If in place of bromine we substitute a few crystals of potassic chlorate and a little hydrochloric acid, the regeneration of the ferric salt is equally perfect.

$$KClO_3+6HCl+3Fe_2Cl_4=KCl+3Fe_2Cl_6+3H_2O.$$

If to this solution a very small quantity of bromine is added it will be easily understood that, so long as there is any potassic chlorate left, the small amount of bromine will be capable of regenerating an unlimited amount of the iron salt.

One part of potassic chlorate is equal to nearly 4 parts of bromine in regenerative power, and, moreover, as as potassic chlorate is quoted at 1s. per lb. and bromine at 4s. per lb., the advantages to be obtained are obvious. When the battery is being actively employed little or no annoyance is caused by the fumes, but in all cases it is best to place it where they can do no harm. Of course the chlorate may be employed with chromic acid, but the results are rather unfavourable.

Potassic permanganate, also, makes an excellent depolariser; and an exceedingly compact and handy little battery—especially suited for intermittent currents, electric bells, &c.—is made by placing a carbon and a zinc plate in a strong solution of the permanganate and ammonic chloride.

It is also interesting to note that exhausted Leclanché cells may be regenerated to a great extent by pouring into the porous cell a strong, warm, and slightly acid solution of the permanganate.

Erdington, July 30, 1887.

THE DETECTION OF CERTAIN VOLATILE HYDROCARBONS IN METHYLIC, AMYLIC, AND OTHER ALCOHOLS.

By H. N. WARREN, Research Analyst.

The following reaction was observed during the analysis of wood naphtha, which having been saturated with anhydrous calcium chloride, in order to retain the methylic alcohol, was distilled, by means of the water-bath, at a temperature of 212° F.

The volatile products collected thereby were afterwards separated by the usual method of fractional distillation, according to their different boiling-points. Among the first products to collect in the receiver was a volatile ethereal liquid, possessed of a boiling-point between 160° to 180° F. On treating the same with caustic soda it was observed, after the lapse of a few minutes, to strike a magnificent blood-red tint. Other alkalies were simultaneously tried: among these baryta, in admixture with a few drops of caustic soda, behaved most successfully, producing immediately a deep blood-red solution, even in very dilute solutions, and of remarkable stability. The same substance was afterwards detected in several samples of petroleum spirit possessed of low boiling-point; similarly also in samples of methylic, amylic, and other alcohols; also during the decomposition of coal-gas by means of chlorine. The product, on account of its low boiling-point, presents considerable difficulty of obtaining it pure, and has hitherto not been pursued further, but would undoubtedly prove a valuable dye for oils, provided it were mixable with the same.

THE SEPARATION OF NICKEL AND COBALT FROM IRON.

By J. B. MACKINTOSH.

As all chemists know, the separation of these metals is, at best, a long and tiresome task. It is generally assumed that two or at most three precipitations of the iron as basic acetate, or as hydrate by ammonia, are sufficient to effect a perfect separation, thus obtaining all the nickel and cobalt in the filtrates. I have found, however, in cases where there is a comparatively large amount of these metals present, as in most meteoric irons, that it is sometimes necessary to repeat the precipitation five or six times, or even oftener, before the filtrates cease to react for nickel and cobalt. In the analysis of one meteoric iron I noticed the very interesting fact that, after all the nickel had been removed, cobalt still remained with the iron, although the amount of cobalt in the sample was not more than one-tenth that of the nickel. At the time when this was noticed the colour of the filtrate on concentration was pink, having previously been green; if I remember correctly, this took place at about the sixth time of precipitation.

The probable reason for the difficulty seems to be that the nickel and cobalt become partially peroxidised, and, possibly, in the case of cobalt, that some of the ammoniocobalt bases are formed, which are either rather insoluble, or are decomposed, with formation of peroxide, upon boiling.

In order to decrease the time and the number of operations necessary, I tried the old method of precipitation of

all three metals from the boiling solution with ammonium sulphide, with subsequent treatment with hydrochloric acid. I thus obtain two portions, the precipitate containing nearly all the cobalt and nickel with very little iron. and the solution containing nearly all the iron with very little nickel and cobalt; both these portions are then treated separately in the usual way by precipitation of the iron, as basic acetate, and a perfect separation may be much more readily obtained than if the solution had been treated directly without this preliminary concentration.

I tested this method on two meteoric irons which I have recently analysed.* and determined the amounts of combined nickel and cobalt found in the two portions after one precipitation as sulphides, and also after three such precipitations. It is to be noted that these operations take very little time, as the precipitated sulphides of nickel and cobalt are easily filtered and washed, and also that the bulk of solutions treated is very small, so that the time occupied by these three precipitations will hardly exceed that occupied by one basic acetate precipitation, and certainly will not when the time necessary for the concentration of the filtrate is taken into consideration. The results obtained are as follows:—

Precipitation of the Boiling Solution with Ammonium Sulphide and Subsequent Solution in Dilute Hydrochloric Acid.

	Total Ni+Co present.	Fe present.	Per cent Ni+Co. In precipitate.	In filtrate.
One precipitation ..	0·0956	1·0266	92·08 p.c.	7·92 p.c.
Three precipitations	0·1248	0·6021	96·32	3·68

In the first case the nickel and cobalt amount to 8·52 per cent of the total weight of metals, and in the second case to 17·17 per cent.—*School of Mines Quarterly*, July, 1887.

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.†

By HELEN C. De S. ABBOTT.
Fellow of the American Association for the Advancement of Science
Member of the Academy of Natural Sciences, Philadelphia;
of the Berliner Chemische Gesellschaft, &c., &c.

(Continued from p. 56).

Extract (3), *the Green Part of the Leaf.*

THE residual powder from the petroleum spirit maceration was thoroughly dried, and again placed in the percolator. It was treated with Squibbs's stronger ether. The *extract* was a deep-green coloured liquid and fluorescent. The reaction was slightly acid. Alcohol, benzol, and petroleum spirit added to the *ethereal extract* did not cause a precipitation. An amorphous and green-coloured residue was obtained on evaporating the *extract*. The amount of total solids was estimated from a definite volume of the *extract*, which was evaporated, dried, and weighed.

Total Solids.

	Per cent.
Ethereal residue dried at 100° C.	1·25 of solids.
,, ,, ,, 110° C.	1·14 ,,
	0·11 of loss.

The *ethereal residue* was brought into a state of fine division and treated with water. The amount of total solids soluble in ether and water was 0·34 per cent. The aqueous extract was neutral in reaction. It was faintly coloured and slightly bitter to the taste. It was not coloured by iron salts nor precipitated with alum and gelatin solution, showing absence of gallic acid or tannin. Copper solutions were not reduced, indicating absence of glucosides, though the precaution was observed of boiling the aqueous extract with acid and rendering alkaline before adding the copper solution. The aqueous extract was agitated with acetic ether and a distinctly crystalline residue separated. Under the microscope these crystals were white, needle-shaped, and arranged in bundles. They did not respond to tests for gallic acid. Potash solution formed a yellow mixture with the crystals. The colour was discharged by a drop of hydrochloric acid. Chloroform did not dissolve any substance from the *ethereal residue*. The *ethereal residue* was treated with acidulated water and tested negatively for alkaloids.

The *ethereal residue* insoluble in water was treated with alcohol. The amount of substances insoluble in water, and soluble in ether and alcohol, was 0·15 per cent. The alcoholic solution was evaporated, and the residue was crystalline in structure. Concentrated sulphuric acid imperfectly dissolved it, and gave a reddish-yellow colour reaction; acetic ether discoloured the solution. The alcoholic residue was insoluble in acetic ether, cold and boiling aqueous alkalies; soluble in chloroform. It saponified with alcoholic soda.

The amount of the *ethereal residue* insoluble in water and alcohol was 0·65 per cent. It was not soluble in alcoholic or aqueous soda. This would indicate a resin anhydride. Concentrated sulphuric acid gave no colour reaction with it; and a mixture of sulphuric acid and cane sugar dissolved the residue.

The *ethereal residue* on treating with cold ether was not entirely soluble in it. It was soluble in chloroform, benzol, and carbon disulphide; incompletely soluble in cold alcohol, and insoluble in amyl alcohol. The *ethereal residue* was treated with 95 per cent alcohol, in which it was slightly soluble. A turbidity formed in the alcoholic solution on adding lead acetate, ferric chloride, ammonium hydrate, and sulphuric acid; it did not clear up on warming. Hydrochloric acid made a muddy mixture with the alcoholic solution. The *ethereal residue* was not entirely soluble in acetic ether; the latter separated colouring matter from it. The *ethereal residue*, insoluble in acetic ether and freed from colouring matter (chlorophyll), was a resinous substance. It melted at 80° C. The resin was boiled with absolute alcohol, and on throwing the alcoholic solution into cold water it was precipitated as a white cloud. It was not saponified.

Extract (4), *Yellow Base of Leaf.*

The residual powder from the petroleum spirit maceration was dried and extracted with stronger ether. The *ether extract* was a turbid yellow liquid, slightly acid in reaction. On evaporating the *ethereal extract* at the ordinary temperature a reddish-yellow granular solid remained. It melted at 79° C. For the determination of total solids extracted, a definite volume of the *extract* was evaporated, dried, and weighed.

I.

Total Solids.

	Per cent.
Ethereal residue dried at 100° C.	1·7 of solids.
,, ,, ,, 110° C.	1·7 ,,
	0·0 of loss.

The *ethereal residue* was treated successively with distilled water, alcohol, and ether.

II.

Substances soluble in ether and water ..	0·8 per cent
,, ,, ,, alcohol ..	0·4 ,,
,, insoluble in water and alcohol ..	0·5 ,,
,, ,, ,, Total solids ..	1·7 ,,

The aqueous extract gave a neutral reaction with litmus. Negative results followed examination for tannin, gallic

* *American Journal of Science*, March, 1887, pp. 225, 232.
† Reprinted from the *Transactions of the American Philosophical Society.*

acid, glucosides, alkaloids, and any compounds containing nitrogen.

The *ethereal residue* (the *residue* insoluble in water) was an opaque reddish-yellow coloured substance, and was identified as a resin. It melted at 79° C. It was insoluble in ether, benzol, chloroform, and acetic ether; incompletely soluble in cold absolute alcohol, amyl alcohol, carbon disulphide, and oil of turpentine. It was soluble in aqueous and alcoholic soda. On boiling with them, it was saponified. Concentrated sulphuric acid dissolved the resin and coloured it a yellowish brown. Chloroform formed a turbid mixture with the acid solution. The action of strong nitric acid on the resin was slow. The resin was incompletely soluble in 95 per cent alcohol. Lead acetate gave a cloudiness with the alcoholic solution which increased on boiling. Ferric chloride thickened the alcoholic solution, and on boiling it gave a yellow precipitate which was insoluble in acids, alkalies, absolute alcohol, and acetic ether. The chloroform extract gave no colouration with bromine solution.

(To be continued).

OBITUARY.

LAURENT GUILLAUME DE KONINCK.

On July 17th died Laurent Guillaume de Koninck, formerly, for close upon thirty years, Professor at the University of Liege. He was born in 1809 at Louvain, where he studied Medicine and the Natural Sciences, and where he graduated as Doctor of Medicine.

In 1835 he was appointed Teacher of Technical Chemistry at the University of Ghent. In 1847 he accepted the Chair of Palæontology and Organic Chemistry at Liege, which he held until his resignation in 1876.

His palæontological researches are recognised as being of very high merit, his last work, "Faune du Calcaire Carbonifère de la Belgique," being unfortunately not yet completed.

Among his chemical labours we notice his researches on salicine, phloridzine, populine, and potassium sulphocarbamylate. In 1839 he brought out his "Elements de Chimie Inorganique," in 1865 a "Resumé de la Theorie des Types," and in 1867 "Tableaux des Principales Series des Composés Organiques."

The deceased was, up to his death, one of the editors of the *Revue Universelle des Mines et de la Metallurgie.*

The interment of the departed *savant* took place on July 19th, in presence of representatives of the Government and the most eminent men of Science in Belgium.

CORRESPONDENCE.

ANALYSIS OF VINEGAR.

To the Editor of the Chemical News.

Sir,—Since the preparation of my article upon "Analysis of Vinegar," which you published in Chemical News, vol. lvi., p. 3, I have devised a simple form of tube for use by tradespeople in testing the acid strength of their vinegar in percentages of monohydrated acetic acid. As illustrated by the accompanying cut, it consists simply of a glass tube having a bore of about $\frac{3}{8}$ inch, closed at one end, and long enough to be graduated in the following manner. At the height of 6 c.c. from the closed end it is to be marked o per cent. The space below bears the inscription "Fill with the Vinegar to be tested." Above this mark it is to be graduated for each c.c. up to 10 c.c., with subdivision into tenths. Only "per cent" is to be inscribed in place of the c.c.'s usual upon a burette.

For use, the tube is to be carefully filled with the vinegar up to exactly the o per cent graduation mark. One or two drops only of a tincture of phthalein are to be added, and a normal solution of caustic soda then gradually added, with a thorough mixing of the contents of the tube by closing its mouth by a finger and inverting it after each

addition, till at last a single drop of the soda changes the colour to a permanent pink. The level at which the contents then stands upon the graduation of the tube will indicate the acid strength of the sample of vinegar in per cents and tenths of monohydrated acetic acid with all the accuracy necessary for trade purposes.—I am, &c.,

Bennett F. Davenport.

161, Tremont Street, Boston, Mass.,
July 20, 1887.

MARKING WEIGHED PORCELAIN VESSELS.

To the Editor of the Chemical News.

Sir,—I have found the following simple method of much service, and, not having seen it published, I venture to communicate it. Any desired letters or figures are written on the porcelain with a diamond, then a little platinic

chloride solution is smeared over them, and, after being allowed to become almost dry, is *wiped* (not *washed*) off. On igniting the article so treated the figures stand clearly out, marked in metallic platinum.—I am, &c.,

BERTRAM BLOUNT.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 2, July 11, 1887.

Formation-Heat of Hydrogen Telluride.— M. Berthelot and Ch. Fabre.— Hydrogen telluride cannot be easily obtained by means of zinc or iron tellurides. If these bodies are pure acids do not attack upon them, and if they contain an excess of metal the gas evolved contains much free hydrogen. Magnesium telluride gives the best results. It is obtained by causing the vapour of tellurium in excess to act upon magnesium heated in a current of pure dry hydrogen. We obtain thus a white flocculent body, very unstable in the air, and which, on treatment with dilute hydrochloric acid, gives off abundance of hydrogen telluride. The gas thus obtained is entirely absorbed by potassa. If preserved over mercury it is spontaneously decomposed in a few hours, even in the dark. In contact with moist air the decomposition is immediate. The odour of hydrogen telluride differs notably from that of the corresponding sulphide and selenide. Its action upon the animal system is not nearly so insupportable as that of hydrogen selenide. Hydrogen telluride dissolves rapidly in alkaline solutions. If these are concentrated we obtain crystalline tellurides, white or colourless, giving in *pure* water colourless solutions, but a trace of oxygen gives the liquid a fine violet tint, and an excess of oxygen throws down free tellurium. The formation of hydrogen telluride from its elements takes place with absorption of heat. In one and the same family of simple bodies combined with hydrogen the heat of molecular combination diminishes progressively, and even becomes negative as the molecular weight increases.

Crystalline Form of Quercine.—C. Friedel.

The Klinorrhombic Form and the Optical Characters of Prismatic Arsenious Acid.— M. Des Cloizeaux.—These two memoirs do not admit of useful abstraction.

A New Method of Preparing Acetyl-cyanacetic Ether.—MM. Haller and Hold.—The authors dissolve 23 grms. cyanacetic ether in its weight of absolute alcohol. and add a solution of 4·6 grms. of sodium in 60 grms. of the same alcohol. To this mixture are then added 8 grms. acetyl chloride in 20 grms. of ether, and the whole is heated until it no longer has an alkaline reaction. We evaporate then in the water-bath, take up the residue in water, shake with ether to dissolve the ethyl cyanacetate which has not entered into reaction, and then decant. The aqueous solution is supersaturated with sulphuric acid and exhausted with ether. The ethereal liquid distilled leaves the cyanic compound as a residue.

Osmotic Equilibrium and the Concentration of Solutions by Gravity.—MM. Gouy and Chaperon.—This paper does not admit of useful abstraction.

Study of the Reactions of the Vanadates from an Analytical Point of View.— Ad. Carnot.— Already inserted.

Rectification of Industrial "Phlegmes." — L. Godefroy.—The simultaneous use of lime and chloride of lime constitutes an efficacious, simple, and cheap process for the purification of crude spirits.

Zeitschrift für Analytische Chemie. Vol. xxvi., Part 1.

The Reactions of the Albumens and their Chemical Detection in Physiological and Pathological Cases. —R. Palm.—The following are special reagents for the albumens not precipitating organic bases. (1) Ferric acetate, rendered previously basic by digestion with an excess of freshly precipitated ferric hydroxide in an alcoholic solution. If slightly heated with the solution in question, even the smallest traces of albumens are precipitated. (2) Alcoholic solution of cupric acetate; the precipitate obtained is dissolved in acetic or lactic acid, the solution mixed with a little soda-lye, and heated to boiling. If albumen is present in the copper precipitate immediate reduction ensues. (3) An alcoholic solution of basic lead acetate or of lead chloride. This reaction has the advantage, as compared with the two foregoing, that the precipitate is colourless, so that the presence of albumen in it can be further confirmed by the colour reaction with glacial acetic acid and sulphuric acid, according to Adamkiewicz. All these three reagents throw down albumens from the peptones, and the precipitate is insoluble in an excess of the precipitant. (4) Freshly precipitated lead hydroxide is slightly soluble in pure water, especialle with the aid of heat. This solution shows the slightest traces of albumens (1 part in 500,000), especially if a littly alcohol is added to the mixture.

The Gas Balance, an Apparatus for Determining the Specific Gravity of Gases.—F. Lux.—An illustrated paper.

Fire-damp Meter for Determining Methane in the Gases of Coal-Mines.— P. von Mertens.— This paper requires the four accompanying figures.

Gasoline Blast and Muffle Furnace.—W. Hoskins. —This memoir cannot be intelligibly reproduced without the accompanying illustration.

Novel Glass Apparatus.—Greiner and Friedrichs.— These appliancee include a double action washing- and absorption-bottle, a washing- or absorption-apparatus, to be charged with solid or liquid and solid absorbents, and glass cocks with oblique perforations.

Remark on Huss's Method for Determining Phosphorus in Iron and Steel.— P. Vorwerk.— This modification of the Sonnenschein process involves a source of error from the organic matters resulting from the solution in nitric acid, the action of which is not annulled by boiling for fifteen minutes, and by the addition of ammonium chloride. The results will, therefore, fall too low.

Filters with a Fatty Margin.— A. Gawalowski. — Certain precipitates creep up over the edge of the filter-paper. To prevent this the author saturates the margin of the paper with paraffin (free from ash), wax, or some other fat.

Analysis of Certain Caucasian Wines.—B. Tairoff. —No novel analytical procedure is described.

Apparatus for Electrolytic Determinations.—Dr. R. v. Malapert.—This memoir requires the accompanying figures.

A Modification of the Otto Acetometer. — W. Fresenius.—As indicator the author uses phenolphthalein, which has the advantage that a single drop is sufficient The new acetometer consists of a cylindrical glass tube, closed at the lower end, 12 m.m. wide and 17 to 18 c.m. long, having a mark at the point up to which it contains 5 c.c., and is graduated from there upwards in c.c. as far as 12. Each c.c. is again subdivided into fifths, so that $\frac{2}{10}$ c.c. can be read off and $\frac{1}{10}$ may be estimated.

Production of Iodide Coatings. — J. Schnauss (*Chemiker Zeitung*).— The author points out that the gypsum tablets used as supports by Haanel, Wheeler, and Lüdeking become dull and crumble away on heating. As a substitute he recommends plates of mica. For Casamajor's modifications see CHEMICAL NEWS.

New Applications of the Nitrometer.—A. H. Allen, G. Lunge, T. Bayley.—A conspectus of the views of these chemists, given in the Chemical News, the *Berichte*, in *Chemische Industrie*, and in the *Journal Soc. Chem. Industry*.

Apparatus for Determining the Heat of Combustion.— W. Alexejew.— An improved modification of the apparatus proposed by Fischer and Schwackhöfer. Modifications of Thomson's calorimeter have been proposed by Stohmann and Rechenberg.

Improvements in Short-arm Balances.— F. Sartorius.—The modifications refer to the adjustment of the knife-edges, and to the suspension of the scale pans (*Chemiker Zeitung*).

Evaporation-Nitch.—W. Hempel (*Berichte*) and C. M. Stuart (Chemical News).

Filter-press for Laboratory Use.— W. Hempel.— The author keeps in view that such appliances should admit of being easily cleansed. Hence he constructs all parts which come in contact with the liquid of glass, porcelain, or caoutchouc.

Preparation of Oxygen and of Hydrofluoric and Hydrofluosilicic Acid.— Iron instruments have been devised for this purpose by Hempel and Muencke.

Determination of Zinc.— G. Lösekann and Th. Meyer.—If a solution of zinc in hydrochloric or sulphuric acid, accurately neutralised with ammonia, is mixed with a sufficiency of sodium phosphate, there is formed a white voluminous precipitate of zinc-ammonium phosphate, which, if heated to a boil, is deposited in a granular-crystalline form. If the precipitate, after filtration, washing, and drying, is ignited over the blast-flame, it melts to a limpid fluid of zinc pyrophosphate, $Zn_2P_2O_7$. Ammonium sulphide produces no turbidity in the filtrate. The following conditions should be observed:—After adding excess of ammonia and sodium phosphate, hydrochloric or sulphuric acid should be dropped in until the reaction is amphoteric. Liquid and precipitate are heated to a boil, filtered after the lapse of six hours, and washed with hot water until the last washings do not show phosphoric acid if tested with molybdenum mixture. The precipitation may be directly effected in an accurately neutralised liquid (containing ammoniacal salt) by the addition of sodium phosphate. This method of operating is not recommended if much zinc is present, as the precipitate does not take a granular crystalline form. It is advisable to use a portion of the substance not containing more than 0·3 grm. of zinc. The quantity of solution of sodium phosphate added (1 : 10) should not exceed 50 c.c. As the melted zinc pyrophosphate often scatters itself in dust, it should be cooled and weighed in a covered crucible. The determination of zinc in presence of manganese cannot be effected in this manner. In presence of magnesia in a sulphuric solution, it succeeds perfectly (*Chemiker Zeitung*).

MISCELLANEOUS.

Royal Jubilee Exhibition, Manchester.— One of the most interesting exhibits in the chemical section of this Exhibition is that of Dr. Theodor Schuchardt, of Görlitz, in Germany, consisting as it does of an excellent collection of rare and new chemical preparations, especially those used in scientific, medical, pharmaceutical, photographic, and technical work. A large amount of time and labour must have been expended in order to bring before the public this proof of the great progress chemistry is making in her ever-extending relations with the different branches of Natural History. We here see 67 inorganic and 190 organic compounds which have never before been produced in such quantity, and at the same time in such a state of purity. The first section consists principally of the rare elements, and those compounds of other elements which may justly be called rare, considering the difficulties to be overcome in their manufacture. First among these we notice selenium and tellurium, both similar to sulphur in their chemical reactions, and found in very few minerals. The pure selenium is shown in very good hexagonal crystals, and the tellurium in the form of brilliant needles of metallic lustre. "Germanium," one of the newest elements discovered by Prof. Winkler, is also shown: up to the present time it has only been found in one mineral, and that a rare one, named "argyrodite," found at Freiberg; its chemical reactions are of great interest, its salts being of a very soluble character. Among the other metalloids exhibited by this firm we may mention a box containing large crystals of silicium, and brilliant leaf-shaped crystals of zirconium. Oxide of zirconium is at present attracting some attention with regard to its magnificent incandescent properties when used in the Welsbach lamp, and it is not improbable that its preparation may before long develope into an industry of some importance. Among the metals exhibited we note two tubes containing potassium and sodium melted in presence of hydrogen, thus preserving their true metallic lustre. There are also to be seen the newly-described cubes of chloride of lime mixed with gypsum, which render it possible to obtain an easily regulated current of pure chlorine gas. Salts of cerium, yttrium, erbium, as well as the metals indium and gallium in spectroscopic purity, are also shown. These last two metals would in all probability never have been discovered except for the spectroscope, as they occur in such minute proportions: the zinc ore near Freiberg, in which indium was discovered, contains only 0·1 per cent of that metal, while gallium, which may be called one of the rarest metals, is found in "black jack" in no larger quantity than 0·001 per cent. Its production in quantity is therefore a matter of extreme delicacy, requiring great care, but it has been successfully carried out by a new method discovered in Dr. Schuchardt's laboratory. Gallium is here shown in both solid and liquid forms, and it is the first time that crystals of this metal have been publicly exhibited. Another interesting body is osmic acid, shown in the form of brilliant fern-like crystals; it has long been used in physiological studies as a means of distinguishing between nerves and veins. The second section, consisting of organic compounds, contains all the most recently discovered and interesting bodies in this branch of chemical science. We first mention "Thiophen," a new organic sulphur compound, which is now being manufactured in considerable quantity by this firm: formerly obtained in the distillation of coal-tar, it is now produced from succinate of sodium and phosphide of sulphur. Following the Catalogue, attention will be drawn to the compounds of croconic acid; there are also its intermediate products, such as diactyl-hydrochinon, &c. Of greater interest may be naphthyl-phenyl-ketondibromide, which is of great service to mineralogists in optical work, on account of its great refractive power; a similar value is attached to the heavy iodide of methylen, used for determining the specific gravity of precious stones, &c. Of the numerous alkaloids exhibited "Wrightin" takes the first place; it is the only alkaloid free from oxygen; it is found in plants, and when in a state of great purity, as in the present instance, it takes the form of long white needles. Other alkaloids here exhibited are hydrastin, from *Hydrastic Canadensis*, possessed of great crystallising powers; scapolin, from *Scapolia saponica*, which is of an extremely poisonous nature, even when diluted to 1 in 5000; and many more. Among other interesting specimens we find a collection of vegetable dyes, chlorophyll, chlorophyllan, phyllopurpurin, orcein, and the interesting group of nitrogen compounds. We cannot conclude without mentioning two new test-papers invented by Charles Wurster: one, saturated with dimethyl-para-phenylendiamin, enables us to detect the presence and quantity of wood fibre in any

paper; whilst the other, saturated with tetra-methyl-para-phenylendiamin, will detect the smallest quantity of active oxygen. The property of the latter paper is of great importance, as by its means the hygienic value of the air at any place can be readily ascertained.

Titration of Phosphoric Acid with Uranium Nitrate.—C. Mallot.—Uranium oxide forms a green lake with the colouring-matter of cochineal. This property may be utilised for giving the determination of phosphoric acid by uranium nitrate increased accuracy and precision. The preliminary operations are supposed to be conducted according to Joulie's citro-uranic method, *i.e.*, solution of the phosphate in hydrochloric acid, precipitation of the phosphoric acid by means of the citro-magnesian solution, and solution of the double ammonium-magnesium phosphate in dilute nitric acid. At this point the author adds to the nitric liquid a few drops of infusion of cochineal (obtained by treating the cochineal with boiling water) and then, with a pipette, ammonia slightly diluted until a violet colour is obtained. This is made to disappear again by acidulating slightly with nitric acid. The liquid is then heated to 100°, 5 c.c., of the acid solution of sodium acetate are added, and the standard solution of uranium nitrate is then dropped in with a burette. Each drop of the uranium nitrate produces a greenish blue spot, which becomes gradually stronger as the end of the precipitation is approached, and which disappears on stirring as long as this precipitation is not complete, leaving the rose colour of the cochineal. At the exact moment when the precipitation is complete the liquid takes a bluish green colour, which undergoes no further change on the addition of a further quantity of uranium nitrate.—*Moniteur Scientifique*, April, 1887.

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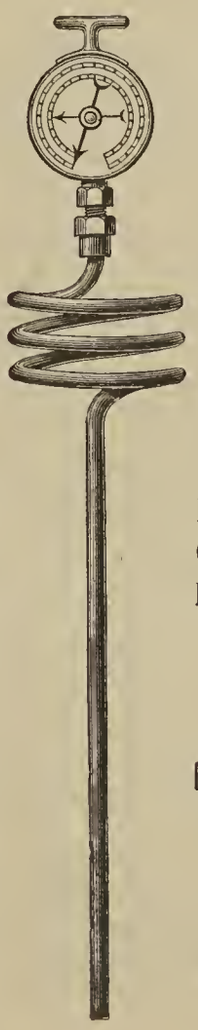

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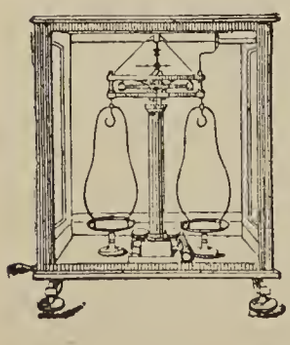

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THE CHEMICAL NEWS.

VOL. LVI. No. 1447.

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT.

Fellow of the American Association for the Advancement of Science; Member of the Academy of Natural Sciences, Philadelphia; of the Berliner Chemische Gesellschaft, &c., &c.

(Continued from p. 66).

THE residues from the *ether extracts* (1) and (2) of the bark and of the wood of the root contained resins which were identified as the same compound. They correspond in colour, melting-point, specific gravity, solubilities, and reactions. The resin is a transparent, ruby-coloured substance, crystalline in structure, and of a softer consistency than ordinary resin. It was examined by Hirschsohn's scheme.† It differed from all described resins in its reactions with the reagents used to identify them. It is proposed to name it yuccal.‡

The experiments with spirit of different strengths are only of value, so far as they were carried out, in showing the possibility of separating the resin into distinct parts.*

Tannin was not present in these *ethereal extracts.*

Ethereal extract (3) was green-coloured and fluorescent from the chlorophyll of the leaves. On evaporating, the *ethereal residue* was amorphous and of a green colour. The aqueous extract obtained from treating this *ethereal residue* was neutral in reaction and bitter to the taste. It contained neither gallic acid, tannin, nor glucosides. It was agitated with acetic ether, and the solvent removed a solid, which under the microscope proved to be white needle-shaped crystals arranged in bundles. Potash solution formed a yellow-coloured mixture with the crystals, hydrochloric acid discharged the colour. The subject has been too little studied to state definitely if these crystals are or are not identical with the crystals found in the *ethereal extracts* (1) and (2). But it should be noted, that unless the crystals from *ethereal extract* (3) are brought into aqueous solution mechanically by some compound not present in *ethereal extracts* (1), and (2), the indications are in favour of the crystals from (3) not being identical with them; for the crystals from (1) and (2) were insoluble in water and not removed by acetic ether.

The *ethereal residue* was treated with acidulated water and tested negatively for alkaloids.

Summary II. *Ethereal Extracts.*

	Solids extracted.	Character of residue.	Reaction with litmus.	Melting point.	Specific gravity.	Substances soluble in ether and water.	Substances soluble in alcohol and water.	Substance soluble only in ether.
1. The bark of the root ..	3·16%	Resin.	Acid.	70° C.	1·091	traces	traces	—
2. ,, wood ,, ..	1·70	,,	Slightly acid.	70° C.	1·091	,,	,,	—
3. ,, green leaf	1·25	,, Chlorophyll.	,, ,,	80° C.	—	0·34%	0·15%	0·65%
4. ,, yellow base of leaf ..	1·70	Resin.	,, ,,	79° C.	—	0·80	0·40	0·50

Yuccal is imperfectly soluble in 95 per cent alcohol; soluble in boiling absolute alcohol, in cold ether, and amyl alcohol; not appreciably soluble in chloroform, benzol, carbon disulphide, and alcoholic ammonia. Cold acetic ether dissolved the colouring matter from the resin, leaving a colourless solid. Hot acetic ether dissolved it perfectly. Yuccal when heated on platinum foil gave off as it burned a pleasant and aromatic odour. Tests failed to show the presence of benzoic or cinnamic acids. A blood-red colour reaction was obtained by warming yuccal with a crystal of ammonium molybdate and a few drops of strong nitric acid. Warm dilute nitric acid dissolved the resin, colourless; cold nitric acid gave a brownish green colour reaction. Yuccal was mixed with concentrated nitric acid and heated. After some time had passed, an energetic reaction occurred and nitrous fumes were given given off. A yellowish brown residue was one of the products of the reaction. This residue was almost insoluble in water or acids. It was soluble in alcohol and potassium hydrate.§

As the *ether extracts* (1) and (2) were concentrated, white needle-shaped crystals appeared floating in the liquids, whose physical structure, and insolubility in water and acetic ether, suggested identical substances. The crystals separated from yuccal by the lead acetate method, already described, have not been sufficiently studied to identify them with the white needle-shaped crystals in the *ether extracts* nor with any class of chemical compounds. However, the absence of gallic acid, glucosides, and alkaloids in the aqueous extracts from the *ethereal residues*, would show that the crystals separated from yuccal are a constituent part of the resin.

The *ethereal residue* insoluble in water was a mixture of two resins (I.) and (II.). The one (I.) was dissolved by absolute alcohol, the other (II.) was mostly soluble in ether. The alcoholic residue was crystalline. It was insoluble in acetic ether, but was saponified with alcoholic soda. The ether residue was a resin anhydride; it was insoluble in alcohol and in alcoholic or aqueous alkalies.

The amorphous and green-coloured *ethereal residue* was not entirely re-dissolved by cold ether. It was soluble in chloroform, benzol, and carbon disulphide; incompletely soluble in cold alcohol, and insoluble in amyl alcohol. It was slightly soluble in 95 per cent alcohol and in acetic ether. The latter separated the green colouring matter from it. The resinous mass insoluble in acetic ether melted at 80° C. It was not saponified. This resinous mass insoluble in acetic ether is a mixture of the two resins just described (I.) and (II.). It was noticeable that the resinous mass was not saponified. Resin (I.) was saponified. Resin (II.) did not saponify, and as this resin exceeded in amount by 0·5 per cent resin (I.), it would show that a certain percentage of resin anhydride in a mixture of two resins forbids the saponification of the mixture.

It was not determined if the crystals dissolved by water and separated by acetic ether were a part of resin (I.) or resin (II.) or an independent compound.

Ethereal extract (4) was a turbid yellow liquid. On evaporating, a reddish yellow granular solid remained. The extract from the aqueous treatment was tested with negative results for tannin, gallic acid, glucosides, and alkaloids. The *ethereal residue* insoluble in water was identified as a resin. It was soluble in ether, benzol, chloroform, and acetic ether; incompletely soluble in cold

* Reprinted from the *Transactions of the American Philosophical Society.*

† *Loc. cit.*

‡ See foot-note, *ether extract* (2).

§ See foot-note 3, *ether extract* (2).

* The amount of material on which these experiments, as well as others described in this paper, were tried, was too small in quantity for me to obtain more conclusive results. The facts which have been acertained will serve as a guide in future investigations.

absolute alcohol, amyl alcohol, carbon disulphide, and oil of turpentine. It was saponified. A resin was extracted by boiling absolute alcohol from the residual powder of the leaves (the yellow base) which was identified as the same resin, and the name of pyrophæal* was proposed for it.

I. Resins (1) and (2) are identical substances (yuccal).

II. *Ethereal residue* (3) is a mixture of two resins, and a crystalline principle soluble in water.

III. Resin (4), pyrophæal, is identical with a resin found in *alcoholic extract* (4).

(To be continued).

ON A SHARP LINE SPECTRUM OF PHOSPHORESCENT ALUMINA.

By WILLIAM CROOKES, F.R.S., Pres. C.S.

(Continued from p. 62).

IN the article published in last week's CHEMICAL NEWS I was only able to illustrate two spectra with cuts borrowed from my previous papers, there being no time to get new spectra engraved. I now fulfil the promise I then made of publishing drawings of the different spectra carefully mapped to scale; at the same time I have had Fig. 1 recut larger, so as to make it comparable with the others. All the spectra are drawn to the $1/\lambda^2$ scale.

Fig. 1 is the spectrum shown by purified alumina before it has undergone many fractionations. This is the same spectrum which I described and illustrated in a paper "On the Crimson Line of Phosphorescent Alumina," sent to the Royal Society December 30th, 1886.

Fig. 2 is a drawing of the most prominent lines in the sharp line spectrum of phosphorescent alumina, as described on p. 60. It was obtained by precipitating alumina by ammonia from the *high* end of the fractionations of pure ammonia alum after more than one hundred crystallisations. The precipitated aluminium hydrate was dried and calcined at a bright white heat.

Fig. 3 is the sharp line spectrum given by phosphorescent alumina obtained by calcining sulphate of alumina from the high end of the fractionation of ammonia alum. As this particular sample of alumina gives a spectrum which is well known to me, I keep it as a standard to try the effects of other earths upon it. Fig. 3 only differs from Fig. 2 in containing some very faint lines omitted from the latter spectrum.

The following Table gives approximate measurements of the spectrum shown in Fig. 3:—

Scale of spectroscope.	λ.	$1/\lambda^2$
10·55	6940	20765
10·48	6773	2180
10·41	6617	2284
10·39	6575	2313
10·36	6514	2357
10·03	6395	2445
10·22	6248	2562
10·20	6214	2590
10·19	6917	2604
10 14	6111	2678
10·13	6095	2692
10·04	5955	2820
10·02	5924	28495
10·01	5909	2864
9·96	5838	2934
9·94	5810	2962
9·92	5782	2991
9·90	5754	3020
9·88	5729	3047
9·81	5639	3145
9·74	5554	3242
9·66	5462	3352
9·63	5430	3392
9·555	5350	3494
9·37	5170	3742
9·07	4922	4128

There are other lines corresponding to those in the samarium-aluminium spectrum, but they are too faint to measure with accuracy.

Fig. 4 is the fine line spectrum given, after ignition to bright whiteness, by the same mixture of alumina with 2 per cent of samaria which yielded Spectrum No. 5 after being only heated to redness. M. de Boisbaudran considers that this spectrum belongs to samarium and corresponds with the one shown in Fig. 5. A comparison of Fig. 4 with Figs. 3 and 5 will, however, show that whilst there is no connection between Figs. 4 and 5, there is the closest resemblance, short of actual identity, between the spectra in Figs. 4 and 3; this proves therefore, that the new sharp line spectrum is caused by alumina, and not by samaria or either of its constituents, Gε and Gγ, or Sδ.

In the following Table are given approximate measurements of the lines shown in the spectrum, Fig 4:—

Scale of spectroscope.	λ.	$1/\lambda^2$
10·49	6795	2166
10·47	6757	2195
10·41	6617	2284
10·39	6575	2313
10·36	6514	2357
10·30	6395	2445
10·22	6248	2562
12·20	6214	2590
10·19	6917	2604
10·14	6111	2678
10·13	6095	2692
10·08	6015	2764
10·06	5985	2792
10·02	5924	28495
10·01	5909	2864
9·96	5838	2934
9·94	5810	2962
9·92	5781	2991
9·88	5729	3047
9 85	5689	30895
9 81	5639	3145
9·74	5554	3242
9·71	5519	3283
9·66	5462	3352
9·63	5430	3392
9·62	5418	3406
9·57	5365	3474
9·54	5335	3514
9·37	5170	3742
9·07	4922	4128

The slight differences between the spectra yielded by alumina (Fig. 3) and by a mixture of alumina and samaria (Fig. 4) are that the well known crimson line, 1 λ^2 20765, which can be seen faintly in the alumina, is not visible in the alumina and samaria mixture, that several of the lines seen faintly in the one are strong in the other, and that there is a slight difference at $1/\lambda^2$ 2820,—where in alumina there is a rather sharp but faint line instead of the two very faint and nebulous bands, at $1/\lambda^2$ 2764 and $1/\lambda^2$ 2792, seen with alumina-samaria. On the whole, except in the case of the crimson line, $1/\lambda^2$ 20765, the chief effect of the 2 per cent of samaria has been to brighten up most of the alumina lines, especially in the red and orange parts of the spectrum.

Fig. 5 is last week's Fig. 2, repeated here for purpose of comparison; it is the figure with which I illustrated

* Pyrophæal. *Science*, September 11, 1885.

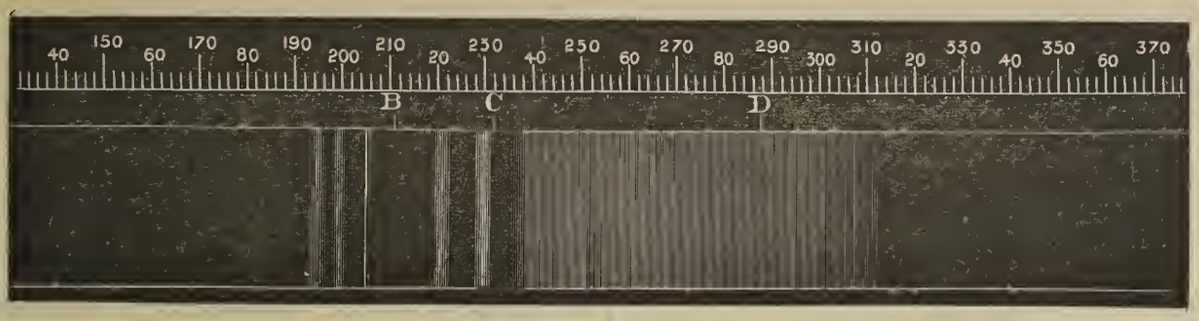

FIG. 1. Alumina, unfractionated. Band spectrum.

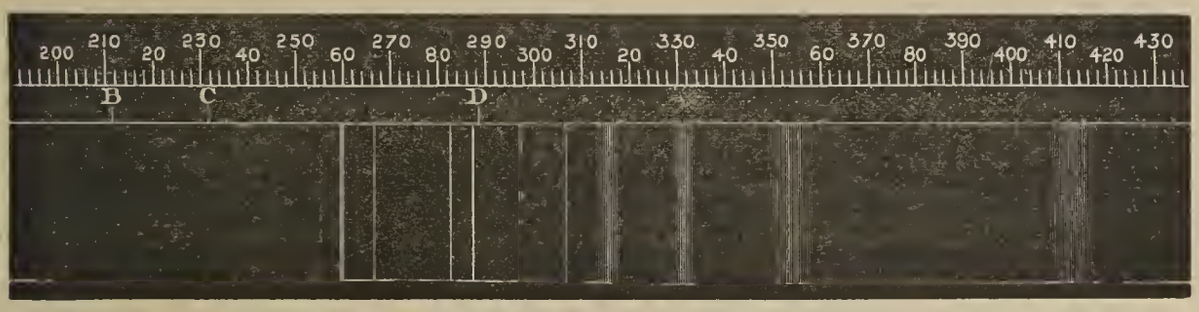

FIG. 2. Alumina, fractionated. Sharp line spectrum.

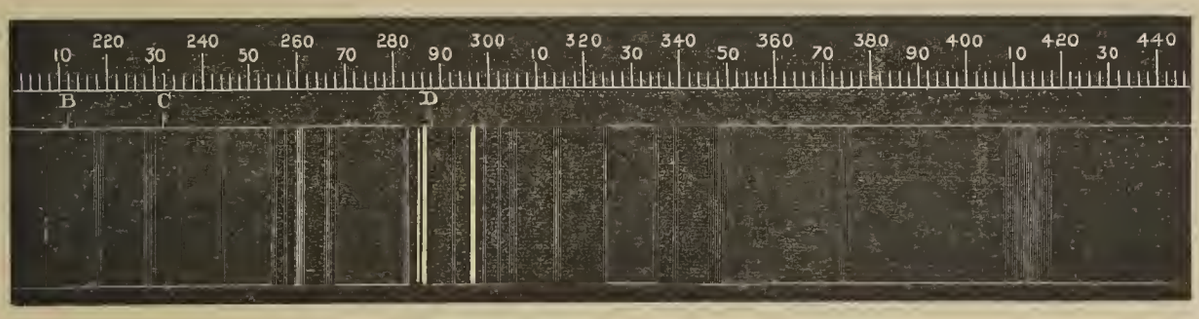

FIG. 3. Alumina, fractionated. Sharp line spectrum.

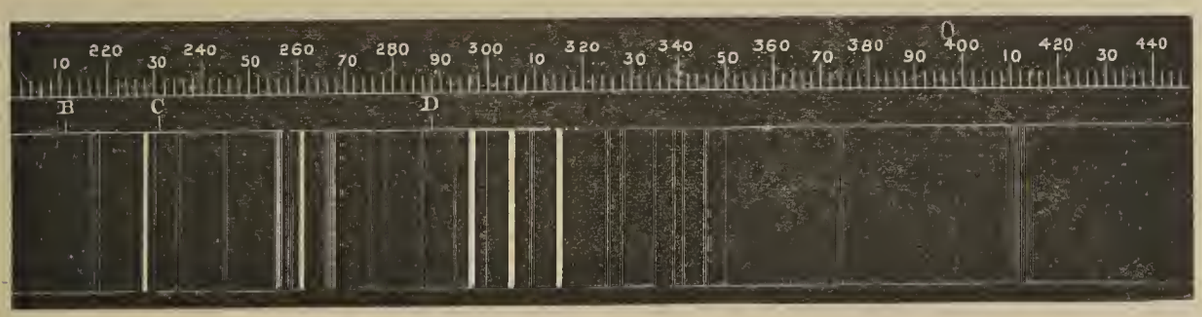

FIG. 4. Alumina-Samaria. Sharp line spectrum.

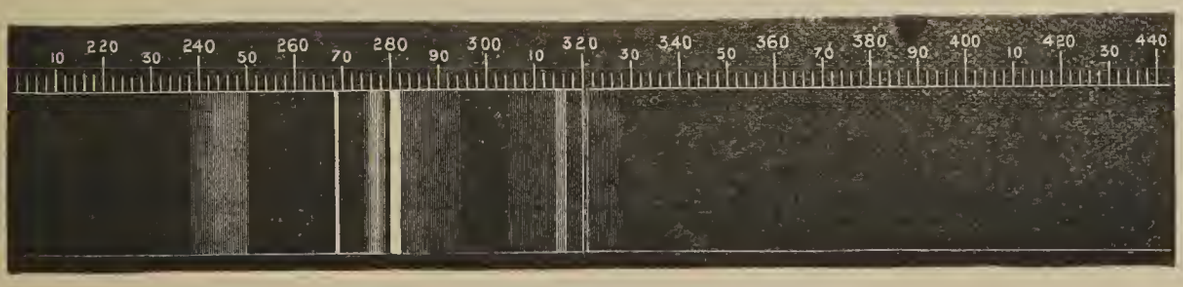

FIG. 5. Alumina-Samaria. Band spectrum.

the Samarium-Aluminium spectrum in my paper of June 18th, 1885. It is the same spectrum that is described by M. de Boisbaudran in last week's *Comptes Rendus* as being yielded by a mixture of 2 per cent samaria with alumina heated to full redness, and it is practically the same as that which I have produced by mixing 2 per cent of samaria with some of the alumina of Fig. 3 and igniting to redness.

ON THE

COMPONENTS OF THE RARE EARTHS GIVING ABSORPTION-SPECTRA.

By GERHARD KRÜSS and L. F. NILSON.

In connection with an inquiry into the equivalent and the atomic weight of thorium, we examined the other rare earths occurring along with thoria in the thorites of Brevig and Arendal. Their nitrates yielded very fine absorption-spectra, displaying several lines peculiar to the compounds of didymium, samarium. erbium, and thulium, as well as to Soret's earth X, and to the holmium compounds.

An accurate measurement of the absorption-spectra of the thorite earths led to the important observation that in this case only a portion of certain absorption-bands peculiar to the rare earths was visible. Thus, of all the lines of Soret's X or of holmium visible in the spectrum of Brevig thorite, only one line was visible with great intensity. It was the band which, according to various authors, is ordinarily given as the sixth faintest band, and plays, therefore, only a subordinate part in the ordinary spectrum of holmium. The more intense lines Xα, Xβ, Xγ, Xδ, &c., were either quite invisible in the spectrum of Brevig thorite, or only very faintly visible. Hence the conclusion was drawn that Soret's X or holmium is no simple body, but consists of at least two constituents, one of which occurs almost free from the other among the rare earths of the Brevig thorite. The nitrate of this earth has, in its absorption-spectrum, only one band at $\lambda = 428{\cdot}7$.

This observation led to a further investigation of the spectra of the rare earths. Besides the earths of the thorites of Brevig and Arendal, there were examined those obtained from Wœhlerite, from the Fergusonites of Ytterby and Arendal, and from the euxenites of Hitterö and Arendal. At the authors' disposal there was also abundant didymium material from the cerite of Bastnäs, and they were finally indebted to Prof. Cleve for some preparations from his last researches on didymium and samarium.

The result of these investigations was that most of the so-called rare elements whose compounds give absorption-spectra are complex bodies. As a preliminary the authors mention briefly the conditions under which the measurements of the absorption-spectra were undertaken.

For the observations they used the universal spectroscope described in *Berichte*, xix., p. 2739, and they employed generally the simple 60° prism of a dispersion $A - H_2 = 4° 18'$ in preference to the use of several prisms, as it was thus possible to observe in a better illuminated spectrum, and the presence of very faint absorption-bands was thus less liable to be overlooked. Besides, in a spectrum of small dispersion all the bands appear more sharply defined than in one produced by a larger system of prisms.

The determinations of locality in the spectrum were effected by means of the cross marked upon the glass plate in the slide of the eye-piece. It can, on the one hand, be moved alone by a micrometer screw provided with a measuring-drum and finger for entire revolutions, and on the other it can be moved along with the observing telescope by a micrometer movement by means of a large measuring-drum for entire rotations.

The values for the wave-lengths of the lines as given in the authors' tables were obtained by means of the latter arrangement. The measurements were carried out on the principle that not the breadth and the position of an absorption-band at any degree of concentration of the solution is very characteristic of a compound, but only the position of the maximum of darkness in such band. The middle of the cross was therefore adjusted to the darkest region of the absorption-bands. If this was impracticable in a band on account of too great absorption, the liquid under examination was diluted until the band had only a small breadth, and its maximum of darkness could then be accurately determined.

As for the intensities of the absorption-bands given, they are only relative statements of the degree of absorption of one and the same solution, the solution of a certain fraction. No attempt was made to bring all the solutions to the same degree of concentration, as it appeared superfluous for the object in view. It seemed merely necessary to determine the relative intensities of the bands always in one solution. The intensities have not been indicated by numbers, *e.g.* from 1 to 10, since a word or two seemed better to express the phenomena observed.

As for the conversion of the values read off on the telescope drum into wave-lengths, the authors once for all standardised their apparatus at a temperature of 17° by observing a great number of Frauenhofer lines and other fixed lines, and carried on the measurements of absorption-spectra at the same temperature.

1. *Thorite of Brevig.*

As mentioned in a former memoir on the equivalent and atomic weight of thorium, the thorite of Brevig contains, in addition to thoria, considerable quantities of other rare earths. After the latter had been separated from the thoria by the process formerly described, the anhydrous sulphate of the mixed earths was dissolved in ice-water, precipitated with oxalic acid, whereby considerable quantities of iron, manganese, and uranium remained in solution, and the oxalates were ignited. The residual brownish-yellow earth was completely converted into sulphate by repeated treatment with water and sulphuric acid. The sulphate was dissolved in 3 to 4 parts of ice-cold water. From this solution the hydrates of the earths were thrown down with ammonia and washed by decantation. They then dissolved readily in nitric acid, yielding a flesh-coloured liquid, which was evaporated down and the residual nitrates of the rare earths were heated for some time more strongly, whilst nitrous vapours escaped. The thorium and cerium nitrates still present were decomposed, and remained as insoluble basic compounds on treatment with water. The filtrate contained the didymium and yttrium earths present in the mineral, and gave the following absorption spectrum.

In Table I. and in all following tables the values given under the head "wave-lengths formerly observed" are those which have been found for the absorption-lines of Lecoq de Boisbaudian, for the element X or holmium as mean results from the measurements of Soret and Lecoq de Boisbaudran. The earlier measurements are by R. Thalen, and those values which are for the present marked as Di have been observed by the authors themselves in didymium materials of different origins. Although it has been shown by the researches of Auer von Welsbach that didymium is composed of two bodies, neodymium (Nd) and praseodymium (Pr), the symbols Nd and Pr have not been introduced into the present investigation, since it appeared that these bodies are still compounds. The symbol Di has been still retained for the total body formerly known as didymium; on the more precise designation of its components see below. The same holds good with holmium, thulium, &c. The didymium lines have not even been accurately measured by the authors, since notwithstanding various accounts concerning them, no accurate and especially no complete

determinations seem to exist. Auerbach's researches, the result of which rests on spectroscopic observations, contain no precise measurements of the didymium spectrum, but merely drawings which allow only of an approximate comparison.

As for the occurrence of the rare earths in the thorite of Brevig, it appears from Table I. that there are present in this mineral, in addition to thorium, erbium, Soret's X, thulium, samarium, and didymium. Further, in the absorption-spectrum of the nitrates there was observed a

(I.) *Thorite of Brevig.*

Observed position of maximum darkness.		Wave-lengths formerly observed.	For.	Intensities of bands.
Position of Telescope-drum.	Wave-length observed.			
2354	728·3	728·3	Di	Rather strong.
2381	708·2	708·2	Di	Very faint.
2411	686·0	684·0	Tm	Extremely faint.
2420	679·3	679·4	Di	Faint.
2457	654·1	654·7	Er	Faint.
2480	640·6	640·4	X	Very faint.
2505	626·1	626·1	Di	Faint.
2568	591·5	591·5	Di	Faint. } Lie on a fainter absorption-ground, extending from λ = 593 to λ = 574.
2596	579·2	579·2	Di	Faint. }
2605	575·4	575·4	Di	Faint. }
2689	539·6	—	(?)	Very faint.
2713	531·3	531·3	Di	Faint.
2721	529·2	530·0	Di	Extremely faint.
2740	523·6	523·1	Er	Strong.
2747	521·6	521·5	Di	Very faint.
2781	512·2	512·2	Di	Faint, broad.
2872	485·9	485·5	X	Very faint.
2888	482·3	482·0	Di	Very faint, but sharp.
2913	476·5	477·7	Sm	Faint.
2944	469·2	469·0	Di	Stronger.
2974	462·3	463·2	Sm	Faint.
3068	445·6	445·1	Di	Very strong.
3076	444·2	444·7	Di	Very strong.
3164	428·7	428·5	X	Strong.
3240	417·3	416·7	Sm	Strong.

(II.) *a. Thorite of Arendal; Nitrates of the Yttria-Earths.*

2413	684·4	684·0	Tm	Rather strong.
2455	654·7	654·7	Er	Stronger than foregoing.
2592	580·9	579·2	Di	Extremely faint.
2682	542·6	542·6	X	Faint.
2698	535·6	536·3	X	Rather strong.
2721	529·2	530·0	Di	Very faint.
2740	523·6	523·1	Er	Strong; stronger than λ = 654·7.
2747	521·6	521·5	Di	Faint.
2864	488·8	—	(?)	Faint; does not coincide with X line λ=485·5.
2920	474·9	474·5	X	Extremely faint.
2943	469·4	469·0	Di	Very faint; at the spot where thulium β=λ465·3 lies there was no line, though Tm α = 684·0 was fairly strong.
3028	452·6	453—449	X	Strong.
3076	444·2	444·7	Di	Faint.
3163	428·9	428·5	X	Scarcely visible.
3240	417·3	416·7	Sm	Rather strong.

b. Thorite from Arendal; Nitrates of the Earths precipitated by Sulphuric Acid.

2353	729·0	728·3	Di	Very strong.
2382	707·5	708·2	Di	Very faint.
2419	680·0	679·4	Di	Faint.
2568	591·5	591·5	Di	Extremely faint.
2595	579·6	579·2	Di	Very strong.
2604	575·8	575·4	Di	Very strong.
2712	531·6	531·3	Di	Extremely faint.
2740	523·6	523·1	Er	Faint.
2747	521·6	521·5	Di	Strong.
2772	514·6	514·6	Di	Faint.
2780	512·5	512·2	Di	Faint.
2887	482·5	482·9	Di	Strong.
2920	474·9	474·5	X	Faint.
2943	469·4	469·0	Di	Strong.
2974	462·3	463·2	Sm	Extremely faint.
3068	445·6	445·1	Di	Strong.
3076	444·2	444·7	Di	Strong.
3163	428·9	428·5	X	Very faint.

(III.) *Wœhlerite from Brevig.*

Observed position of maximum darkness. Position of Telescope-drum.	Wave-length observed.	Wave-lengths formerly observed.	For.	Intensities of bands.
2354	728·3	728·3	Di	Strong.
2420	679·3	679·4	Di	Faint; the thulium line λ = 86·4 not visible.
2455	654·7	654 7	Er	Rather strong.
2505	626·1	626·1	Di	Very faint.
2568	591·5	591·5	Di	Faint.
2596	579·2	579·2	Di	Strong.
2604	575·8	575·4	Di	Strong; λ = 579·2>575·4.
2688	539 9	—	(?)	Faint, sharply defined; observed also in the spectrum of the thorite of Brevig.
2698	535·6	536·3	X	Faint.
2741	523·3	523 1	Er	Strong.
2747	521·6	521·5	Di	Strong.
2773	514·3	514·6	Di	Faint.
2782	511·9	512·2	Di	Very faint.
2864	488 8	—	(?)	Does not coincide with the X line λ = 485·5 which was not perceptible in the wœhlerite material.
2887	482·5	482·0	Di	Rather strong.
2911	477·0	477·7	Sm	Faint.
2944	469·2	469·0	Di	Strong.
2975	462·1	462·3	Sm	Extremely faint.
3030	452·3	453—449	X	Extremely faint.
3068	445·6	445 1	Di	Strong.
3076	444·2	444·7	Di	Very strong.
3164	428·7	428·5	X	Faint; equal X λ = 536·3
3240	417·3	416·7	Sm	Very faint.

(IV.) *Cerite from Bastnäs: Didymium and Samarium Material.*

2353	729·0	728·3	Di	Strong.
2405	690·5	—	(?)	Very faint.
2420	679·3	679·4	Di	Rather strong.
2480	640·6	640·4	X	Scarcely perceptible.
2505	626 1	626·1	Di	Faint; resolvable into two fine lines at λ = 623·4 and λ = 618·8
2595	579·6	579 2	Di	Very strong.
2604	575 8	575·4	Di	Very strong.
2712	531·6	531·3	Di	Faint.
2735	525 2	—	(?)	Faint.
2747	521·6	521·5	Di	Very strong.
2772	514·6	514·6	Di	Faint.
2780	512·5	512 2	Di	Faint.
2887	482·5	482·0	Di	Strong.
2911	477·0	477·7	Sm	Faint.
2943	469·4	469 0	Di	Stronger than λ = 482 0.
2970	463·2	463·2	Sm	Very faint.
3070	444·2	444·7	Di	Very strong.
3135	434·0	—	(?)	Very faint.
3163	428·9	428·5	X	Faint.
3240	417·3	416·7	Sm	Faint.

faint but distinct line at λ = 539·6, which cannot be identified with any line hitherto observed in the spectra of the rare earths.

2. *Thorite from Arendal.*

On the occurrence of other rare earths in Arendal thorite along with thoria, and on the separation of these earths, one of the authors has formerly reported (*Berichte*, xv., p. 2524). The sulphuric solution of the mixed earths finally obtained was completely saturated with potassium sulphate, and thus the yttria earths were separated from the earths precipitable by potassium sulphate. Both were again converted into nitrates, and gave solutions for which were found the absorption-spectra (II.).

The thorite from Arendal, like that of Brevig, contains, therefore, nearly all the rare earths whose compounds produce absorption-spectra; further, at λ = 488·8, there was observed a line hitherto unknown. Hence it appears that in the thorite of Arendal, as in that of Brevig, there exists a rare earth not yet recognised. As regards the method of separating didymium from the yttria earths by saturating the solution with potassium sulphate, the tables (II.) show that in this manner only an imperfect separation is effected. The solution of the sulphates of the mixed earths was saturated with potassium sulphate for some days until no more double sulphates were precipitated. Yet, in the spectrum of the yttria earths, several didymium lines—certainly faint—were observed, and, on the other hand, in the spectrum of the earths precipitated by potassium sulphate there were found one erbium and two X lines.

3. *Wœhlerite from Brevig.*

In Wœhlerite neither yttria earths nor cerium metals had been hitherto discovered, though this mineral had been analysed by Scheerer and Rammelsberg. The analyses of both these chemists sum up only to 98·90 per cent, and are therefore not quite complete. On working up one kilo. of Wœhlerite the authors found about one per cent of rare earths. The pulverised mineral was dis-

solved in hydrochloric acid, and from the solution previously freed from silica and niobic acid the greater part of the zirconia was precipitated as oxychloride by an excess of hydrochloric acid. The filtrate was then mixed with an excess of oxalic acid, by which all the yttria and cerite earths and some niobium and zirconium remaining in solution were precipitated. The mixed oxalates were ignited, the oxides dissolved in nitric acid, the nitrates formed were partially decomposed by heat and treated with water, when the niobium and zirconium compounds remained insoluble, and a solution was obtained containing only the stronger rare bases of Wœhlerite, which served for the spectroscopic investigation (III.).

In Wœhlerite there occurs, besides the elements given in the analyses of Scheerer and Rammelsberg, and the rare earths above named, uranium, since, in the spectrum of Wœhlerite the lines Ur_α, Ur_β, Ur_γ, and Ur_δ have been distinctly observed.

4. *Cerite from Bastnäs.*

A material of rare earths obtained from the cerite from Bastnäs, and which contained didymium in the old acceptation of the word, gave the spectrum (IV.) in the solution of its nitrates.

b. Perfectly identical with the above spectrum is that of a didymium material due to the kindness of Prof. Cleve. It must be noticed that in the material from Bastnäs, as well as in that supplied by Prof. Cleve, there were three faint lines $\lambda = 690{\cdot}5$, $525{\cdot}2$, and $434{\cdot}0$, which could not be identified with any absorption lines hitherto known. The interpretation that these lines had escaped notice because the solutions used were not sufficiently concentrated or were observed in too shallow a layer is not admissible, since, in the tables contained in this memoir, the authors had the opportunity of observing spectra in which other didymium lines, generally faint, were strongly visible, but the three lines did not appear. There is, therefore, in the didymium material from the cerite of Bastnäs and in Cleve's material, besides Sm, X, and didymium in the ordinary meaning, a small quantity of another element.

(To be continued).

IDENTITY OF THE PHOTOSALTS OF SILVER WITH THE MATERIAL OF THE LATENT PHOTOGRAPHIC IMAGE.

By M. CAREY LEA, Philadelphia.

In the first part of this paper I described certain strongly coloured forms of silver chloride, bromide, and iodide, obtained independently of any action of light, for which I proposed the name of photosalts, by reason of their identity with the products of the action of light on the normal silver haloids, both with the substance of the latent image itself and also with the principal results of the continued action of light on these haloids. It remains to prove this identity.

First as to identity with the product of the continued action of light.

If we expose silver chloride precipitated with excess of HCl to light, we get a deep purple-black substance which boiled with dilute nitric acid gives up a little silver, at the same time somewhat lightening in colour, and forming a dull purple material which closely resembles some of the forms of photochloride described in the first part of this paper,—most those produced by the action of sodic hypochlorite or of ferric chloride on metallic silver: it shows the same reactions with ammonia that they do. The brighter coloured photochlorides are not formed by the action of light on silver chloride.

But these brighter coloured chlorides can also be shown to be formed through the action of light. Most salts of silver darken by exposure, and when these dark products are treated first with HCl, and then, after thorough washing, are boiled with dilute nitric acid, we can obtain results perhaps as varied as those which I described in the former part of this paper as arising from purely chemical action.

Silver oxalate exposed for two days to sunshine, covered with water, and with frequent agitation, changed to a deep brownish black, which by treatment with HCl became a little lighter. When this product was washed and boiled with strong nitric acid it acquired a fine deep copper-red colour, the acid taking up silver. This red substance dissolved in ammonia readily, leaving a small amount of black residue; the same with sodium hyposulphite.

(This examination, made a year ago, has recently been repeated, with a view to obtaining a quantitative determination of the proportion of Ag_2Cl contained in the red product. The exposure was for about a day; the oxalate at the end of the exposure seemed absolutely black. After treatment with HCl it assumed a purple-black shade. After thorough washing and boiling with dilute nitric acid, which removed a large quantity of silver, perhaps 12 or 15 per cent of the entire quantity, it had a fine lilac-purple colour. Analysis showed that it contained about one-half of 1 per cent of subchloride, or, more exactly, 0·45 per cent Ag_2Cl was found).

The red chloride thus obtained from silver oxalate not only closely resembles the red chloride obtained by means exclusively chemical, but shows the same behaviour to reagents.

Treated with ammonia it dissolves, leaving a black residue. The formation of this residue takes place precisely in the same manner with both substances. As fast as the material dissolves the liquid becomes clouded, and an extremely fine black substance seems to form within it, which gradually falls to the bottom.

Treated with solutions of the alkaline haloids, the red chloride derived from exposed silver oxalate remains unchanged after twenty-four hours' contact with potassic chloride, and becomes paler and more lilac under potassic bromide; under potassic iodide it becomes grey. These reactions correspond with those of the photochloride.

Silver phosphate belongs to the more sensitive silver salts, and easily darkens in sunlight. In a few hours it becomes greenish all through, after which further exposure produces little visible effect. This product becomes with HCl quickly grey, and by treatment with nitric acid, after washing, light pink.

Silver tartrate by exposure to sun became quite black. With HCl this changed to reddish grey or dull pink. This product, well washed, and let stand with cold nitric acid 1·36, became first lavender and then light pink.

Silver carbonate by prolonged exposure became greenish black, and with the above treatment yielded a dull pink photochloride.

Silver pyrophosphate, even by several days' exposure to winter sun, did not blacken, but assumed an ochreous or buff shade. With HCl this passed to a sort of salmon-pink, and by heating a few minutes with dilute nitric acid to a beautiful copper shade.

Silver acetate was singularly little affected by sunlight; it looked blackish, but on closer inspection was found to be very little altered. By the same treatment as above it yielded a pale pink photochloride.

So far as examined, all silver salts thus treated yielded pink or red photochloride.

These facts may serve to show the identity of the photochloride with the principal product of the continued action of light on silver chloride and on other salts of silver, subsequently converted into chloride. I should wish, however, to use this word identity in a somewhat limited sense. When the photochlorides are formed by different methods, without the aid of light, hardly any two forms can be considered absolutely identical: they differ in colour and in proportion of subchloride, as already often mentioned; but they also differ in other respects, especially in resistance to reagents. Some forms are far more easily destroyed by nitric acid: those obtained by the

action of sodium hypophosphite (as presently to be described) are amongst the most easily destroyed by nitric acid. There is variation, too, in the degree of their resistance to ammonia.

Very similar differences are found in the stability of the photochlorides obtained by the action af light; some are much more readily attacked by nitric acid than others. The product obtained by the action of light on silver chloride resists ammonia more strongly than that obtained by the action of HCl on exposed silver oxalate. This last is quickly attacked. Generally, I think the dark coloured forms are the most stable.

At a future time it may perhaps be possible to distinguish more exactly between these varieties.

I next pass to the consideration of the identity existing between the photosalts and the material of the latent image. Before entering, however, on that matter, it is necessary to describe a reaction leading to the formation of these photosalts, somewhat differing from the reactions already mentioned, and which has important bearing on the subject.

The remarkable action which an alkaline hypophosphite exerts on salts of copper was described many years ago by M. Wurtz. Its action on silver salts, though there is no parallelism between the two, has enabled me to find a key to some of the great difficulties of the latent image.

A dilute solution of sodium hypophosphite, if poured over a mass of chloride, bromide, or iodide of silver formed in the absence of light, produces no visible effect, but has the property of bringing those substances into the condition in which they exist in the latent image. Applied in strong solution, and with the aid of heat, it produces brown-purple photochloride, bromide, and iodide of silver. I will here briefly describe the first of these compounds in order to continue the series of photochlorides, and then pass to the consideration of the latent image.

Photochloride of Silver by Sodium Hypophosphite.

Silver chloride, freshly precipitated with excess of HCl and well washed, placed in a flask with a strong solution of sodium hypophosphite and heat applied, begins to darken before the boiling-point is reached. Actual boiling for ten or fifteen minutes gives a deep chocolate colour. This product, well washed and freed from traces of metallic silver by cautious boiling with very dilute nitric acid, has a pink, red, or brown colour, varying in intensity according to the length of the action. Sometimes a lavender shade is produced, and this is more apt to be the case when the silver chloride has been precipitated with excess of silver nitrate instead of excess of HCl.

Silver determinations of two specimens of the purified product were made, indicating the presence in one specimen of 1·77 per cent of subchloride, in the other of 3·53.

By the continued action of heat for many hours a complete reduction to metallic silver takes place.

Photochloride obtained in this way has generally a brown or dull purple colour. Boiled with nitric acid it is apt to break up in as many minutes as some other forms would require hours for decomposition, yielding white chloride, whilst the nitric acid takes up small quantities of silver.

Identity of Photosalts with the Material of the Latent Image.

It is proposed here to show—

1st. That, in the entire absence of light, sodium hypophosphite is able to affect a sensitive film of silver haloid exactly in the same way as does light, *producing a result equivalent to a latent image formed by light*, and capable of development in the same way as an actual impression of light.

2nd. That these two effects, the impression produced by hypophosphite and that by light, comport themselves to reagents exactly the same way, and seem every way identical.

3rd. That the image produced by hypophosphite on silver chloride always gives rise to a positive development, but on silver bromide may give rise either to a direct or to a reverse image, *both of these effects corresponding exactly with those of light*. More than this, sodium hypophosphite may be made to reverse the image produced by light on silver bromide, and conversely light may be made to reverse the action of hypophosphite. So exact a correspondence in these remarkable properties can scarcely be fortuitous.

I.

A silver haloid formed in the absence of light, and subjected to the action of sodium hypophosphite, gives rise to the gradual formation of subsalt, which combines with the normal salt in the manner described in the previous part of this paper. This action of the hypophosphite closely corresponds with that of light. In its initial stages it is invisible, but can be brought out, in both cases by development.

If we form a film of chloride, bromide, or iodide of silver, and with a glass rod dipped in solution of hypophosphite make marks upon it, these marks can with the utmost ease be developed in precisely the same way as an image produced by exposure to light.

A very simple mode of operating consists in imbibing photographic paper with a solution of an alkaline haloid, drying, applying a silver solution, and then thoroughly washing, all of course with careful exclusion of active light. If the silver solution is acidulated with nitric acid, a drop to the ounce, the result is brighter, but this is not important. In any case the washing must be thorough.

Marks made on this paper can be developed with the oxalate developer with the utmost facility. If a strong solution of hypophosphite is applied cold, it may be washed off at the end of a minute, but a stronger impression is obtained by allowing it to wait half an hour before developing. Or the action may be accelerated and increased in strength by laying the freshly marked paper on a hot surface, or, better, by steaming it, before applying the developer. A convenieht mode of steaming is to lay two pieces of glass on a small water-bath kept boiling, with a space between them. Over this space the paper is rested for two or three minutes. Paper prepared with a solution of KCl, KBr, or KI, dried and floated on acidulated solution of silver nitrate and well washed, if marked with strong solution of hypophosphite and steamed for two or three minutes, will develop the marks as black as ink on a white ground. The use of heat simply gives a blacker development, but a very vigorous image may be got without.

(A similar result may be obtained by substituting for the hypophosphite a dilute solution of potash and an oxidisable organic substance. With milk sugar the action is very energetic, and heat is quite superfluous).

Both these are the initial steps of reactions which, when prolonged, result in the visible formation of the coloured photosalts. It is a matter of interest that sodium hypophosphite which produces the above-described effects has no developing power whatever.

II.

The two impressions, that formed by light and that by hypophosphite, are similarly affected by reagents.

As an example of this identity of effect produced on the two impressions, I first take the action of nitric acid.

Chloride, bromide, and iodide papers were exposed to moderate diffused light under a screen with openings for a proper time to form a latent image, the chloride and bromide for four or five seconds, the iodide for twenty or twenty-five. They were then cut into halves and one-half of each was soaked in strong nitric acid for five minutes. These halves were then washed for some hours, and were developed along with the halves not so treated. Result was, latent image on silver chloride almost if not quite uninjured; on silver bromide, somewhat affected but still strong; on silver iodide entirely destroyed.

Similar portions of the same papers were then marked with hypophosphite, and were cut into halves, and one-half was subjected to the action of nitric acid in exactly the same way as the previous. The result was exactly as before. The hypophosphite marks on the half of the chloride paper that had been treated with acid came out in development as vigorously as on the half that had not been treated. The bromide paper showed the marks weakened by the acid, but still strong; on the iodide not a trace appeared. In all respects the result was the same; what the one resisted the other resisted, what destroyed the one destroyed the other.

Another confirmation is presented by the action of the alkaline haloids upon the latent image.

The latent images produced by light on chloride, bromide, and iodide of silver were all treated with cold and moderately strong solutions of potassic chloride, bromide, and iodide for half an hour, and were then subjected to development. It was found that all three silver salts bore the action of potassic chloride and bromide fairly well; the images were somewhat weakened, but strong developments were obtained without difficulty. But when potassic iodide was applied the latent image was totally destroyed.

The visible effect of the alkaline haloids on the photosalts exactly corresponds with their action on the latent image. Potassic chloride and bromide, applied in moderately strong solution, and cold have little effect, but potassic iodide quickly destroys them.

Therefore the action as well of nitric acid as of KCl, KBr, and KI, is exactly the same on the latent image impressed by light on AgCl, AgBr, and AgI as it is on the corresponding photosalts.

III.

The impressions produced by alkaline hypophosphite upon silver chloride always give rise to direct images, darker than the ground on which they are formed. The same substance produces an impression on silver bromide which may, by development, produce either a direct or a reverse image. So that there is a perfect parallelism with the action of light.

The reverse action of light, sometimes called solarisation, shows itself as follows. A film of bromide being exposed to light, part covered by an opaque screen, the exposed portion receives an impression capable of development, and this impression grows in strength to a certain point, then recedes and reaches a condition in which it is less susceptible of development than before exposure. All bromide films, even unexposed to light, will darken in a developing solution in time. The portion that under the action of light has reached the reverse stage, resists the reducing action of the developer better than that which was not exposed at all, and consequently appears after development as light on a dark ground, and is therefore a reverse image. As to the cause of this action we are as yet wholly in the dark. If the continued effect of light was simply to restore the affected part to its original state, we might attempt an explanation by affirming that the continued action of light undid its own work. But the fact of the resistance to reduction being greater than before exposure, shows that some as yet unknown action of light is in play. The reverse action cannot be due to oxidation, as has been suggested, because hypophosphite reverses and certainly cannot oxidise.

The reversing action of light on silver bromide finds its counterpart in the action of sodium hypophosphite.

If we take bromide paper (it is immaterial whether in making it the bromide or the silver solution be applied first, but for these experiments on the reversal of the image it is essential that a pure neutral silver solution be employed, and that after the second solution has been applied the paper should be thoroughly washed, all the operations being, of course, performed by inactive light):—If we take such paper and make marks on it with a strong solution of hypophosphite, and then throw the paper into potassio-ferrous oxalate, we shall get a direct development; the marks will be stronger than the ground. If now we continually weaken the hypophosphite solution, we shall presently reach a point at which these marks are in development almost wholly indistinguishable from the ground on which they were made. But continuing the dilution still further, we presently reach a point at which the marks reappear, but this time reversely, as lighter marks on a darker ground. This result is obtained with about a two per cent solution; the first mentioned effect comes with a solution of 25 or 30 per cent. So that, according as we use the hypophosphite solution stronger or weaker, we obtain exactly opposite effects. Here the parallelism is striking but not perfect, at least it remains to be explained why the action in the two cases proceeds in a reverse order. All the other reactions show a perfect identity.

Time will also sometimes produce the same effect as dilution. Paper marked and put way for twenty-four or forty-eight hours, giving at first a direct image, may after that time give a reverse one. This effect is extremely uncertain, and, I think, exceptional. I have kept very many pieces for periods from a few hours to several weeks, which first and last gave direct images only; a few became reversed. But the experiment itself, the opposite effect of strong and weak solutions, is liable to no such uncertainty.

Again, we may make light and hypophosphite interact and each reverse the other's action.

To make hypophosphite reverse the action of light, I take a piece of silver bromide paper, expose it to the action of diffused daylight for a few seconds, then, taking it to the dark room, make marks upon it with a glass rod dipped in solution of hypophosphite. On developing with potassio-ferrous oxalate the marks appear lighter than the ground. Or what is perhaps more striking, we take two pieces of such paper, retain one in the dark room and expose the other from 5 to 20 seconds to diffused light, then make marks on both with a glass rod dipped in strong solution of hypophosphite, and then, after allowing a few minutes for the hypophosphite to act, place them both in a solution of potassio-ferrous oxalate. The marks will develop, in the one case, as dark on a light ground, in the other (that exposed to daylight) as light on a dark ground.

We have here made the hypophosphite imitate the action of light: it has reversed the image in the same way as would result from a prolonged exposure to light. It will next be shown that light may be made to imitate the action of hypophosphite, and reverse the effect already produced by that or other reducing agent.

If we take the red or purple silver bromide, preparing it with exclusion of light, and the same precaution as in the case of a dry plate, and extend it over paper (it is best, though not essential, to mix it with a little gelatin to enable it to retain its hold on the paper in the subsequent treatment), dry it, and expose it to light under a screen, such as a piece of opaque stiff pasteboard with openings cut in it; then apply potassio-ferrous oxalate, we shall obtain a very remarkable effect; all the parts exposed to light take a reversed development, and appear as lighter spaces on a dark ground. And this goes so far that we may expose till we get a visible and quite strong image, darker than the ground, and yet in development this darker portion will come out lighter than the ground. Indeed, I have one specimen which shows almost white figures on an intensely black ground. Before development these light figures were brown, by exposure to light, on a rose-purple ground. I have seen few more curious results than this.

From the foregoing it follows that red bromide, notwithstanding its intense colouration, is in the same condition respecting light as normal silver bromide that has received an impression of light so strong that any further influence of light would cause reverse action, only that a vastly larger proportion of its molecules are affected. In the case of the latent image formed by light on normal

bromide, it would seem that the particles affected, although numerous enough to serve as a basis of development, are still too few and too scattered to be visible or affect the colour. The photobromide, on the contrary, has its mass made up of them. Then, if exposed to light, the light carries them a stage farther—brings them to the reverse or "solarised" condition, and the parts affected by light develop less strongly than those not exposed.

So light can act the part of hypophosphite and hypophosphite that of light, interchangeably; each can produce a direct action, each a reverse, and each can reverse the other.

It then appears that in all the numerous ways in which it is possible to compare the photosalts with the material of the latent image they are found to be identical. The proofs based on development generally, and especially on the reversal of the latent image, seem very strong, and these receive additional support from the exact identity of reactions shown by the photosalts and by the material of the latent image.

The question of the identity of the photosalts with the products of light on the silver haloids might perhaps be left with some confidence to the cumulative proofs here offered. But I hope to be prepared to give in a future number of this journal additional evidence from a new direction.—*American Journal of Science*, June, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 3, July 18, 1887.

The Transmission between the Aromatic and the Fatty Series. — MM. Berthelot and Recourda. — The passage from a body of the fatty series to a body of the aromatic series by dehydration is accompanied by a considerable escape of heat, that is, by a loss of energy corresponding with the excess of stability acquired by the fundamental hydrocarbonic nucleus.

Solidification of Liquids by Pressure. — E. H. Amagat.—Theoretically, Thomsen's formula enables us to foresee that at a given temperature the solidification of a body may become possible under a sufficient pressure, on condition that its density shall be greater in the solid than in the liquid state. The previsions of this formula have been verified for several bodies by W. Thomson, Mousson, Bunsen, Hopkins, and Batelli. The author has in this manner solidified carbon disulphide at $-19{\cdot}5$ under a pressure of 210 atmospheres, at 0° under 620, at $+10^{c}$ under 900, and at 19·5° under 1160. It may be asked if there is not, for each liquid, a temperature above which solidification cannot be produced at any pressure, that is to say, a critical point of solidification.

A New Method of forming the Cyanomalonic and Benzoyl-cyanacetic Ethers.—Alb. Haller.—In former series of communications presented to the Academy the author has shown that the malonic and benzoyl-acetic sodium ethers, on treatment with cyanogen chloride, yield cyanic compounds which behave like true acids. These derivatives may also be obtained by setting out from cyanacetic sodium ether, which is treated with chlorocarbonic ether or benzoyl chloride.

Preparation of Pure Valerianic Acid.—E. Duclaux. —The author uses an excess of amylic alcohol and keeps the liquid cold. A little acetic acid is also formed, but both are easily separated from each other in dilute liquids by distillation. The valerianic acid passes over almost entirely in the first quarter of the distillate.

MISCELLANEOUS.

Imperial Russian Technical Society.—*Notice from the Organisation Committee of the Exhibition for Mineral Oils Industry and Lighting Materials.*—By His Imperial Majesty's authorisation the Imperial Russian Technical Society organises in the present year 1887 an Exhibition of lighting materials, and mineral oils. To the Exhibition are admitted all apparatus and materials serving for producing and applying every kind of artificial light, and materials referring to mineral oils industry. The programme will include:—(*a*) Historical collections of apparatus and materials serving for lighting in ancient times. (*b*) Lighting by solid and liquid materials of vegetable and animal origin. (*c*) Gas lighting materials, and apparatus for its manufacture and use. (*d*) Lighting by electricity. (*e*) Special sources of light. (*f*) Lamps for burning mineral oils. (*g*) Photometry. (*h*) Mineral oils and their derivatives. Apparatus and contrivances for procuring, preserving, transporting, and treating mineral oils. (*i*) Heating apparatus fed by mineral oils and their derivatives. (*j*) Mineral oils for lubricating. The Imperial Russian Technical Society, in organising the present Exhibition, has chiefly in view to show the present technical state of lighting, and of mineral oils production, and, in accordance with this aim, will pay special attention to a most complete collection of objects, presenting peculiar qualities, and in general being able to characterise the state of the above named branches of industry. For the most important and useful inventions, besides medals and diplomas of honourable mention, money premiums will be awarded. The Exhibition will be opened in the month of November of the present year and will last three months. The exhibits will be received from the 27th of August to the 27th of October. In bringing this to public notice, the Committee of the Exhibition invites all those who desire to participate therein to make known their claims as soon as possible, and not later than the 27th of August, with the mention of objects to be exhibited and necessary space (length, breadth, and height). For space no charge is made. Applications to be made by letter or personally from the 13th of May on Mondays, Wednesdays, and Fridays, from 12 till 2 o'clock, to the Committee of the Exhibition at the following address:—St. Petersburg, Panteleimonovskaja, No. 2; The Russian Imperial Technical Society; To the Committee of the Exhibition. The rules of the Exhibition and all the necessary information can be obtained at the same place.

Substitute for Fehling's Solution. — Schmiedeberg recommends an alkaline solution of copper in which mannite is used in place of the salt of Seignette.—*Chemiker Zeitung.*

The London Hospital and Medical College,
MILE END, E.

The SESSION 1887-88 will commence on Saturday, October 1st, 1837. The New Buildings which were opened by T.R.H. The Prince and Princess of Wales, on May 21st, afford more than double the accommodation which was provided formerly.

FOUR ENTRANCE SCHOLARSHIPS, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All Resident and other Hospital Appointments are free, and the holders of all the Resident Appointments are provided with rooms and board entirely free of expense. The Resident Appointments consist of five House Physiciancies, five House Surgeoncies, one Accoucheurship, and one Receiving-room Officer; Dressers and Maternity Pupils also reside in the Hospital. Special Classes for the Preliminary Scientific and Intermediate M.B. Examinations of the University of London and for the Primary and Pass Examinations for the Fellowship of the Royal College of Surgeons of England are held throughout the year. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis, and the Metropolitan, Metropolitan District, East London, and South-Eastern Railways have stations within a minute's walk of the Hospital and College.

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THE CHEMICAL NEWS.

VOL. LVI. No. 1448.

ON THE LINE SPECTRA OF PHOSPHORESCENT YTTRIA AND LANTHANA.

By WILLIAM CROOKES, F.R.S., Pres. C.S.

(Continued from p. 62).

I GIVE below carefully drawn maps and tables of the phosphorescent spectra of yttria and lanthana described in the CHEMICAL NEWS for August 12th, together with tables giving the approximate measurements of the lines shown in the drawings.

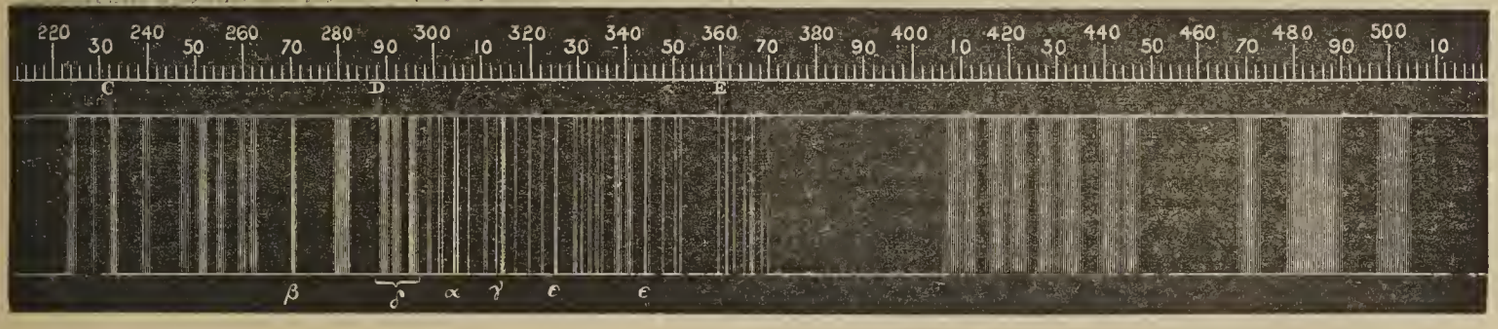


FIG. 1. Yttria. Phosphorescent spectrum.

The following table gives approximate measurements of the yttria lines shown in Fig. 1 :—

	Scale of spectroscope.	$1/\lambda^2$	λ.	
	10·440	2240	6681	Faint, nebulous.
	10·410	2283	6618	Very faint, nebulous.
	10·380	2328	6554	Faint, nebulous.
	10·335	2393	6464	Faint, nebulous.
	10·275	2481	6349	Nebulous, stronger than last.
	10·250	2518	6302	Stronger and sharper.
	10·225	2554	6257	Sharp, but not so bright as last.
	10·195	2598	6204	Very nebulous pair.
	10·180	2620	6178	
β	10·120	2707	6078	Sharp, very bright.
	10·050	2806	5970	Centre of an exceedingly faint nebulosity.
δ	9·990	2892	5880	Faint, nebulous.
δ	9·970	2920	5852	Brighter than last.
δ	9·950	2949	5823	Brightest part of a band shaded off towards the yellow.
	9·925	2984	5789	Faint, but sharp.
	9·905	3013	5761	Very faint pair.
	9·900	3019	5755	
α	9·8815	3045	5731	Very bright pair.
α	9·8793	3048	5728	
	9·860	3075	5703	Faint, sharp.
	9·830	3117	5660	Very faint, nebulous.
	9·820	3131	5651	Very faint, sharp.
γ	9·810	3145	5639	Nebulous, strong.
	9·790	3173	5614	Very faint, nebulous.
	9·770	3200	5590	,, ,,
	9·750	3228	5566	,, ,,
ε	9·730	3256	5542	Nebulous, strong.
	9·702	3294	5510	Nebulous, faint.
	9·695	3304	5501	Sharper than last, faint.
	9·680	3324	5485	Nebulous, faint.
	9·670	3338	5473	Sharp, faint.
	9·660	3352	5462	Very faint.
	9·635	3385	5435	Nebulous and faint.
	9·620	3406	5419	,, ,,
ε	9·595	3440	5392	Sharp.
	9·590	3447	5386	Sharp, faint.
	9·570	3474	5365	Very faint.
	9·550	3501	5343	,, ,,
	9·545	3507	5340	,, ,,
	9·480	3594	5275	Faint
	9·465	3615	5259	,,
	9·460	3622	5254	,,
	9·440	3648	5236	,,
	9·425	3668	5221	Strong, nebulous.
	9·410	3688	5208	Faint.
	9·400	3702	5197	,,
	9 100	4089	4945	Faint nebulous pair.
	9·070	4127	4922	
	9·030	4178	4892	Faint nebulous pair.
	8·990	4229	4863	
	8·950	4279	4834	Fainter nebulous pair.
	8 910	4329	4806	
	8·840	4416	4759	Fainter nebulous pair.
	8 800	4465	4733	
	8 600	4706	4610	Very nebulous, wide.
	8·540	4777	4575	Commencement of nebulosity.
	8·440	4896	4519	End of nebulosity.
	8·350	5001	4472	Very faint, nebulous.

The following table gives approximate measurements of the lanthana lines shown in Fig. 2 :—

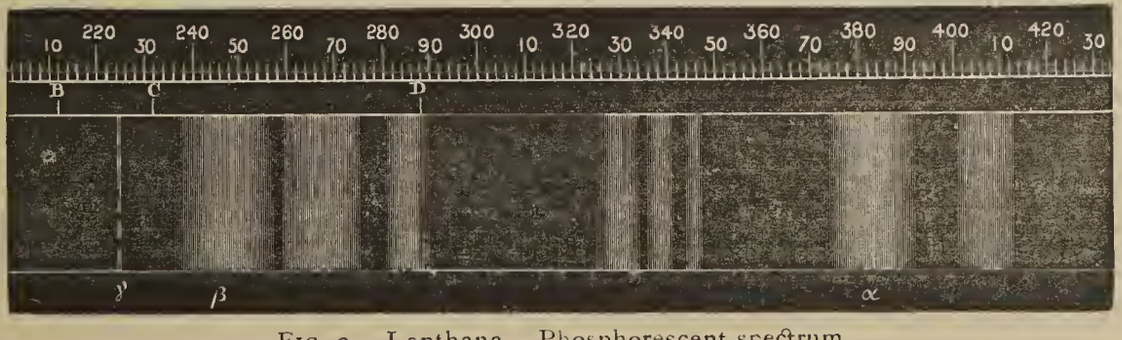


FIG 2. Lanthana. Phosphorescent spectrum.

	Scale of spectroscope.	$1/\lambda^2$	λ.	
γ	10·44	2240	6681	A tolerably sharp line, faint.
β	10·35	2371	6494	Approximate edge of very nebulous band.
β	10·27	2489	6339	Point of maximum brightness.
β	10·23	2546	6267	Approximate end of band.
	10·18	2620	6178	Approximate beginning of nebulous band.
	10·11	2720	6063	End of band.
	10·02	2850	5924	Centre of a nebulous band.
	9·70	3296	5508	Centre of a nebulous blue band.
	—	—	—	Here come two exceedingly faint bands which it is not possible to measure accurately.
α	9·30	3832	5108	Centre of an intensely bright blue nebulous band.
	9·11	4076	4953	Centre of a faint blue band.

RAPID METHODS FOR THE DETERMINATION OF SILICON, SULPHUR, AND MANGANESE IN IRON AND STEEL.*

By J. JAS. MORGAN.

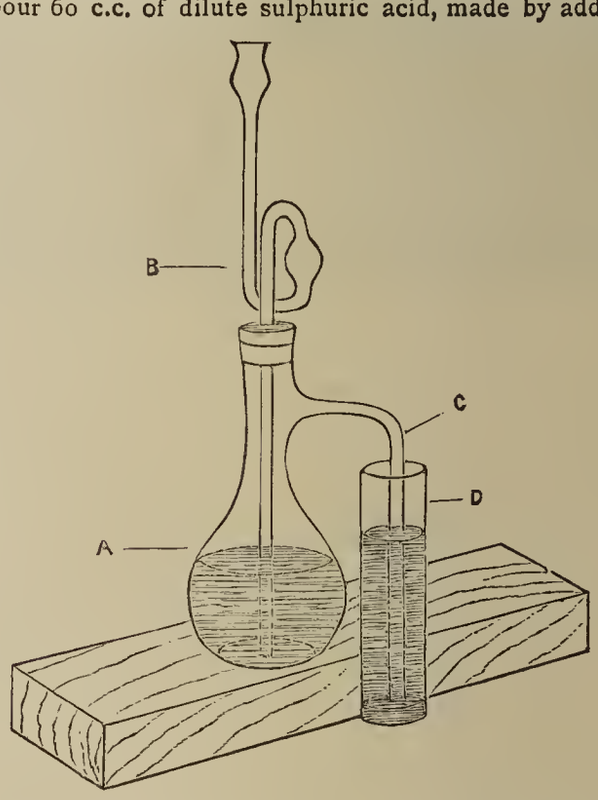
VERY often it is required to ascertain the chemical composition of a piece of iron or steel with the utmost despatch, and as the methods of analyses previously described in the author's articles on "Iron and Steel Analysis," whilst giving accurate results, occupy considerable time to perform, the author thought that an article giving abbreviated† methods, whereby the time occupied is considerably shortened, would be of service to the manufacturer, chemist, &c.

Two of the methods—viz., the estimation of silicon and sulphur, are due to Mr. John Parry, F.C.S., &c., chemist to the Ebbw Vale Iron Company, in whose laboratory they have been in use for a considerable period, giving every satisfaction.

Silicon.—Is estimated by what is termed the "roasting" process, which consists of heatiag in a muffle, at a bright red heat, a portion of the finely-divided sample, whereby the silicon is oxidised into silica, and any graphite present burnt off. Upon treating the roasted mass with hydrochloric acid all, with the exception of the silica, is dissolved; this is collected, burnt, &c. The quantity taken for analysis varies, according to the percentage of silicon in the iron—with irons containing 1 per cent or over 1 grm. is taken, under 1 per cent 4 grms. Having weighed out the quantity, place it in the muffle for twenty minutes. (The employment of too high a temperature and prolonged heating should be avoided, otherwise great difficulty will be experienced in dissolving the mass upon the subsequent treatment with acid). At the expiration of this time the dish, together with its contents, are withdrawn and allowed to cool. To prevent the mass of iron from sticking to the dish, which it is very apt to do, upon withdrawing from the muffle give it a gentle push with a glass rod, taking care not to lose any. In a beaker of 300 c.c. capacity place 100 c.c. of hydrochloric acid, and to this add, when cool, the mass of iron, brushing in any portions which may be attached to the dish; heat gently. When all besides the silica and, perhaps, a little graphite, if present, which may have escaped burning, is in solution, dilute with water, filter, wash well, burn, and weigh the silica, which should be of a white colour. The method, which was at first used solely for pig-irons, has been found by the author to answer equally well with steels.

Colorimetric Estimation of Sulphur.—It is well known that sulphuretted hydrogen, when passed through a solution of a lead salt, produces a brown colouration, varying in intensity according to the strength of the lead solution. By treating a sample with sulphuric acid, passing the evolved gases, sulphuretted hyrdogen, &c., through a dilute solution of lead acetate, and comparing the colour produced with that obtained by treating a standard steel, in which the sulphur has been carefuliy determined by the barium chloride method, in a similar manner a large number of determinations may be made in a very short time, and the samples classified, supposing the standard to contain 0·100 per cent of sulphur, as containing *over* or *under* 0·100, 0·075, 0·050, or 0·025 per cent of sulphur by taking portions of the standard solution and diluting with water until the desired strength is obtained. The solution of lead acetate is made by dissolving 0·200 grm. of the salt in one litre of water free from sulphates.

The method is as follows:—0·500 grm. of the sample is weighed out and placed in the flask, A, and in the cylinder, D, 50 c.c. of the lead solution. Place on a hot plate, arranging the flask so that the tube C dips into the solution contained in the cylinder, and through the funnel, B, pour 60 c.c. of dilute sulphuric acid, made by adding



three parts of water to one of acid. When solution is complete the gas remaining in the flask is expelled by pouring in hot water, taking care to prevent it overflowing into the cylinder; withdraw the flask and compare the colour of the solution with that obtained by treating 0·500 grm. of the standard in a similar manner. As sulphuric acid forms a white precipitate of lead sulphate with lead acetate, it is essential that the apparatus be perfectly free from the acid, also to avoid using a high temperature, which would drive over some acid fumes.

With a lead solution of the strength mentioned the method is available for samples containing not over 0·18 per cent of sulphur, but by using a weaker solution, say half the strength, determinations up to 0·25 per cent may be made. The method is most suitable for determining whether the sample contains more or less sulphur than the standard solution, but with practice and the division of the standard into various strengths, as before mentioned, results agreeing within 0·01, and even less, of the percentage, as determined by the barium chloride method, may be obtained, which for general purposes is sufficiently accurate.

Manganese.—The method is a modification of Mr. Peters's, which is based upon the colour produced, due to

* Communicated by the Author. From the *Industrial Review*.

† Absolute accuracy is not claimed for the methods, but for general purposes they are sufficiently near.

the oxidation to permanganate, when lead peroxide is added to a solution of iron or steel in nitric acid containing manganese. In a test-tube, similar to that used for the estimation of carbon, place 0·200 grm. of the sample to be tested, and in a like tube the same quantity of a "standard" steel, in which the manganese has been carefully determined by weight. To each add 5 c.c. nitric acid, sp. gr. 1·20, and boil in a beaker of hot water until solution is complete. Cool the tubes, and to each add an equal bulk, about 2 c.c., of water; replace in the beaker, and, after boiling for a few minutes, add an excess of lead peroxide, which must be free from manganese, and ten drops of nitric acid, sp. gr. 1·42. After boiling for four minutes the tubes are withdrawn and placed in a beaker of cold water.

When the peroxide of lead has completely settled, transfer 2 c.c. of the clear supernatant liquid of the "standard" solution to the graduated tube used in the colorimetric estimation of carbon, dilute to 5 c.c. with cold water; mix. In a similar tube place the same quantity of the solution of the sample which is being tested, diluting with water until its colour is of the same intensity as that of the standard. Read off the number of c.c. to which dilution is carried, from which, by a simple proportion sum, the percentage is easily calculated.

The "standard" used should contain the same percentage, as near as possible, as the sample tested. If, after complete solution, cooling, &c., the carbon be estimated and the solutions made of equal bulk, peroxide of lead added, &c., as above directed, the same portions will suffice for the estimation of manganese and carbon. The acid used should be free from chlorine, otherwise the colour, which should be purple, will be destroyed.

As regards the estimation of phosphorus, the author recommends the "molybdate" process (for method see *Industrial Review* for May 28), it being, in his opinion, more *reliable*—in the hands of an expert operator—than the "magnesia" process. Some chemists object to it, on account of the phospho-molybdate precipitate being slightly soluble in hydrochloric acid, but ammonium-magnesium phosphate is also soluble both in its mother-liquor and in the water with which it is washed when on the filter. Thus a double loss is incurred. To remedy this loss by washing, ammonia-water is used, in which it is only slightly soluble. The loss or error in weighing the yellow precipitate does not make such a vast difference in the resulting percentage as with the magnesium precipitate, where a loss or error in weighing amounting to 0·002 grm. would equal a percentage of 0·0558, whilst with the molybdate process it would only amount to 0·0032. The whole secret of the "molybdate" process lies in having the right quantity of nitric acid present, which can only be arrived at after considerable practice.

QUANTITATIVE DETERMINATION OF GOLD AND ITS SEPARATION ESPECIALLY FROM THE PLATINUM METALS.

By L. HOFFMANN and G. KRÜSS.

The methods for the separation of gold from other metals which depend on its easy reduction have been submitted to close examination, as the current statements on this point are in part defective and in part inaccurate. The reducing agents which have been considered are sulphurous acid, oxalic acid, and ferrous chloride.

Before these separations were undertaken it was ascertained by especial experiments what degree of accuracy in the determination of gold can be reached by the reduction of its solutions, in order to form a precise opinion as to the trustworthiness of these methods, and as to the quantity of the platinum metals carried down in the preparation of pure gold. The gold employed had been carefully purified. Weighed quantities were dissolved in nitro-hydrochloric acid; the auric chloride was repeatedly evaporated down with pure hydrochloric acid until small quantities of gold began to separate out. The liquid was diluted and treated with the reducing agent. After precipitating the gold, washing, drying, and igniting, the weight was determined by observing the oscillations and interpolating. This seemed requisite, since the quantity of the possible contamination of the gold by platinum metals could be very small.

1. *Precipitation with Sulphuric Acid.*

The determination of gold by precipitating its solutions with sulphurous acid is not proposed in any accessible text-book of analytical chemistry. Rose, Fresenius, Menschutkin, von Miller-Killiani, Classen, recommend merely ferrous salts or oxalic acid for the precipitation of solutions of gold. This metal may, however, be quickly and accurately determined by the use of sulphurous acid. In the authors' experiments the gold found was 99·915 per cent of that taken.

It is advantageous not to use very highly dilute solutions, as otherwise the gold is thrown down in a very fine powder. The solutions, slightly concentrated if needful, are digested for about half an hour on the water-bath with aqueous sulphurous acid, until the liquid becomes perfectly clear, and, on the further addition of sulphurous acid, the smell remains. The gold can then be filtered at once, whilst the complete precipitation by ferrous chloride or oxalic acid requires a longer time. The determination with sulphurous acid has over the oxalic method the advantage of being more accurate, since the evolution of carbonic acid occasioned by the oxidation of the oxalic acid may easily occasion a slight loss by spirting. As compared with the ferrous chloride method it has the advantage that the gold is much more easily washed than that soiled with iron.

2. *Precipitation with Oxalic Acid.*

The gold was reduced by means of oxalic acid, with the aid of heat, until the addition of more acid produced after a considerable time no further separation of gold. The reduction was effected in a covered glass. The mean quantity of gold obtained was 99·88 per cent.

3. *Precipitation with Ferrous Chloride.*

The reduction was effected at a gentle heat on the water-bath, and after filtration the gold was completely washed with hydrochloric acid and hot water. The yield of gold was 99·96 per cent.

Of these three methods precipitation with oxalic acid occasioned the greatest loss of gold. Such loss is possible in any of the three methods, since the gold separates out here and there in such a fine state of division that traces of it may pass through the filter.

A method which avoids this risk, and yields in all cases —even if the solution is very dilute—precipitates easy to filter, is the precipitation of a solution of auric chloride with elutriated mercuric oxide. This method, first proposed by J. Volhard, gave 100·03 per cent of gold. The solution, after admixture with mercuric oxide, was gently heated on the water-bath, when the precipitate collects together in a gelatinous mass. The elutriated oxide had been obtained by decomposing mercuric chloride with the purest soda-lye prepared from metallic sodium. The mercuric chloride had been previously twice mixed with mercuric oxide, and sublimed.

Separation of Gold from the Platinum Metals.

Since many instances are known where the platinum metals do not behave the same with solvents and precipitants when mixed or alloyed as when existing separately, it could not be foreseen with certainty whether platinum, iridium, palladium, rhodium, and ruthenium, when accom-

panying gold in solution, are precipitated in small traces by the above reducing agents or not.

1. *Separation of Gold and Platinum.*

Hydrochloric solutions of auric chloride, containing a known proportion of gold, were mixed with neutral platinum chloride and reduced as above. The gold obtained with sulphurous acid was 100·54 per cent, with oxalic acid 100·005 per cent, and with ferrous chloride 100·24 per cent. Hence it appears that oxalic acid effects a complete separation of platinum from gold, whilst small quantities of platinum are carried down both by the sulphurous acid and the ferrous chloride processes. This was at once perceptible to the eye, since the two latter precipitates had not a pure gold colour, but were grey. This result was not to be expected, since Rose and Fresenius—in addition to the precipitation as double platinum-ammonium chloride—recommend only precipitation with ferrous chloride. "By this method of separation (with ferrous chloride)," says Rose, "a very accurate result is obtained."

According to the above analyses the gold precipitated by ferrous chloride is platiniferous. This agrees with the fact that platinum chloride is partially reduced by ferrous sulphate, though only on prolonged boiling.

The gold thrown down by sulphurous acid also contained platinum, which, after weighing and re-dissolving the product, could be obtained as the double ammonium chloride.

To separate gold in solution from platinum by means of oxalic acid is, according to Rose, not advisable. The above analyses show, on the contrary, that gold may be most safely separated from platinum by means of oxalic acid.

2. *Separation of Gold and Iridium.*

Solutions of auric chloride were mixed with solutions of sodium and iridium chloride, free from acid. The latter salt was selected because finely divided or alloyed iridium dissolve only in insignificant quantities in aqua regia. Iridium black was mixed with two equivalents of sodium chloride, and ignited in a current of chlorine gas; the product was left for about eight days over fresh soda-lime, treated with water, and separated by filtration from undissolved indium. Precipitation with sulphurous acid gave 100·005 per cent of gold, with oxalic acid 99·975 per cent, and with ferrous chloride 99·94. Gold and iridium may therefore be completely separated either by sulphurous acid, oxalic acid, or ferrous chloride.

3. *Separation of Gold and Palladium.*

The solutions of auric chloride were mixed in five cases with solution of crystalline potassium-palladium chloride, and in three with the mixture of palladious and palladic chloride, obtained by dissolving palladium in aqua regia, and repeatedly evaporating down with hydrochloric acid until all acid was expelled.

On precipitation with sulphurous acid the mean percentage of gold obtained was 99·96; with oxalic acid the quantities varied from 99·62 to 100·48, and with ferrous chloride from 99·85 to 100·62.

Sulphurous acid effects, therefore, a complete separation of gold and palladium, whilst oxalic acid and ferrous chloride give a result which varies according to circumstances.

4. *Separation of Gold and Rhodium.*

Finely divided rhodium was converted into chloride by ignition in a current of chlorine: the chloride was mixed with two parts of sodium chloride, and again heated in a current of chlorine. The product, freed from uncombined chlorine, dissolved almost completely in water as rhodium-sodium chloride, and was added to solutions of auric chloride of a known strength.

With sulphurous acid the mean percentage of gold was 100·035, with oxalic acid 99·83, and with ferrous chloride 100·025 per cent. All these methods can therefore effect a complete separation of gold from rhodium.

5. *Separation of Gold and Ruthenium.*

Metallic ruthenium was converted into a double sodium chloride, similarly to iridium, and the clear neutral solution was added to auric solutions of known strength.

With sulphurous acid the mean yield of gold was 99·945 per cent, with oxalic acid 99·92, and with ferrous chloride 99·93. All these agents therefore effect a complete separation of gold and ruthenium.

Hence it appears that gold can be fully separated from platinum only by oxalic acid, from palladium only by sulphurous acid, but from iridium, rhodium, and ruthenium by all three reducing agents. The separation of osmium and gold was ignored, since osmium cannot be present in solutions of gold evaporated down in aqua regia. Under these conditions osmium evaporates quantitatively as tetroxide.—*Liebig's Annalen*, Vol. ccxxxviii., p. 66.

NOTES ON THE USE OF IRON SULPHATE IN AGRICULTURE.

By Dr. A. B. GRIFFITHS, F.R.S. (Edin.), F.C.S. (Lond. and Paris).

The readers of the Chemical News are acquainted with my published papers on the use of ferrous sulphate for agricultural purposes. Perhaps the following notes may be of interest:—

I. *Grass Land infested with Moss.*

In my paper (*Journ. Chem. Soc.* [*Trans.*], 1886, p. 114) it was shown that iron sulphate completely destroys moss in grass land infested with it, but does *not* destroy the grass. The reasons for this are given in that paper. I have received a letter from M. P. Marguerite-Delacharlonny (a well-known scientist of Paris) confirming these results. He says:—

"J'ai employé ($FeSO_4$) pour la destruction des mousses et avec succès égale 250—350 kilogrammes par hectare; avec 100 kilogrammes la destruction est incomplète."

Mr. J. J. Barlow (Oak Lane Farm, Whitefield, Manchester) has also obtained similar results upon grass land infested with moss.

II. *Iron Sulphate* versus *Parasitic Fungi.*

Iron sulphate is now established as a destroyer of parasitic fungi (Chemical News, vol. xlix., p. 279; *Journ. Chem. Soc.* [*Trans.*], 1886, p. 119; Chemical News, vol. liii., p. 255; vol. lv., p. 276; and *Chemiker Zeitung*, No. 47). One of the pests of this year to our farm crops is a micro-fungoid growth which causes tubercular swellings upon the roots of *Vicia faba* (bean). About three months ago I was informed that in the neighbourhood of Etton, near Peterborough, the crops of winter beans have been this year a failure. Mr. G. W. Edgson (a large agriculturist) kindly sent me a number of bean plants for inspection. They were about 7 inches in length, and I have preserved several in weak alcohol. Mr. Edgson says in his letter:—

"The roots of the winter beans you will find are covered with small boils, which appear to be living upon the plant, and have kept the bean plants in the stage you now see them. For the last few months the crop in this district has been a failure. Not having seen anything like it before, I thought it would be interesting for you to see them."

I found (from a microscopical study), upon the roots of the bean plants, tubercular swellings which are due to the growth of a parasitic fungus with small spores. The mycelium of this bean-root fungus and also its spores are destroyed by iron sulphate On treating the hyphial filaments of the fungus and its spores with a solution of iron sulphate upon a slide under the microscope, one could see the perforation of the cellulose walls of the organism, exactly in the same way as I have so often observed in cases of microscopic fungi generally.

I see that Prof. H. Marshall Ward, M.A., F.L.S., has published a paper (read before the Royal Society, June 16th, 1887) on the subject, and he informed me that he is making a complete study of this fungoid growth. I sent, about two months ago, specimens of the roots of *Vicia* from the district of Eiton, with a rough drawing of a microscopical slide I have prepared of this root fungus, to Prof. Ward.

III. *Iron Sulphate for Vines.*

As yet I have not made any experiments on the value of iron sulphate as a manure for vines. It is stated in a pamphlet which I possess concerning Australian wines, that "the Tintara vineyard was originally planted by an early settler, the late A. C. Kelly, M.D., and its position was selected on account of the *ferruginous* constituents of the soil at Maclaren Vale." On the other hand, I have been reminded that, "in the vineyards of Lorraine, the vines growing in the soil overlying the ironstone mines are anything but satisfactory, either in growth or quality."

It is well known that an *excess* of iron in a soil may cause a soil to become barren. It will be remembered that the late Dr. Voelcker, F.R.S., found that certain soils in Hampshire and Bedfordshire were completely sterile on account of the iron sulphate and iron pyrites which they contained amongst the other constituents of the soils. To answer this point I will quote from a pamphlet kindly sent to me by Dr. Munro, F.C.S. ("Report by Prof. Wrightson and Dr. Munro on the Manurial Value of Basic Cinder," p. 20):—

"A sample of soil sterile from the presence of sulphate of iron was found by the late Dr. Voelcker to contain 0·7 per cent of that substance. Now, if the soil were only 4 inches deep and of average density this would amount to *four tons of sulphate of iron per acre*, and it does not at all follow, from the sterility of this soil, that a dressing of ½ cwt. or 1 cwt. per acre of green vitriol, applied in a manure, would cause the slightest damage to any crop."

I have always recommended ½ cwt. of ferrous sulphate to the acre as a top-dressing. On the other hand, my brother, Mr. E. A. Griffiths (British Vice-Consul at Nagasaki, Japan) informed me some time ago that Dr. O. Kellner, of the Imperial College of Agriculture of Tokyo, Japan, was working upon the same subject; and I see, from *Landwirthschaftliche Versuchs-Stationen*, 1886, pp. 365—370, that in 1883 he conducted experiments with ferrous sulphate in *varying quantities*, when *no* harmful influence on the plants in any stage of their growth was observed.

I intend to experiment with vines, using iron sulphate as a manure.

There are five rather long essays on the "Effets utiles du Sulfate, de Fer en Agriculture," by Marguerite-Delacharlonny, in the *Journal de l'Agriculture* for May 14th, 21st, June 4th, 11th, and 18th, 1887.

6, Rue de Bagneux, Faubourg St. Germain,
Paris, August 15, 1887.

ON THE

COMPONENTS OF THE RARE EARTHS GIVING ABSORPTION-SPECTRA.

By GERHARD KRÜSS and L. F. NILSON.

(Continued from p. 77).

5. *Samarium and Praseodymium Material.*

The samarium material was derived from different minerals; it contains Sm‴ of the atomic weight 150·0, and yielded, in a nitric solution, Spectrum V.

As for the praseodymium material, it also had been obtained from various minerals. It yielded, like Auer von Welsbach's praseodymium, a greenish nitric solution. Its spectrum was composed as in Table VI.

6. *Fergusonite from Arendal and Ytterby.*

As formerly communicated in the *Berichte* (xx., 1676), considerable quantities of rare earths had been amassed by occasion of a study on the rare earths and the niobic acid of Fergusonite. This material, which was obtained from 2 kilos. Fergusonite from Arendal, was resolved (by a decomposition of the nitrates twelve times repeated) into different fractions, which contained the earths arranged in the order of their basicity. The nitric solu-

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V. *a. Samarium from Cleve.*

Observed position of maximum darkness.		Wave-lengths formerly observed.	For.	Intensities of bands.
Position of Telescope-drum.	Wave-length observed.			
2595	579·6	579·2	Di	Faint.
2604	575·8	575·4	Di	Very faint.
2645	558·7	559—556	Sm	Faint.
2725	528·1	530·0	Di	Extremely faint.
2749	521·0	521·5	Di	Extremely faint.
2825	500·4	501·5—497	Sm	Rather strong.
2863	489·1	—	(?)	Very faint.
2882—2920	483—475	486—472	Sm	Extremely strong.
2970	463·3	466—460	Sm	Very strong and well defined.
3030	452·9	453—449	X	Extremely faint.
3080	443·5	444·7	Di	Strong with indefinite margin.
3240	417·4	416·7	Sm	Very strong.
3300	409	409	Sm	Faint.

VI. *b. Praseodymium from Cleve.*

2353	729·0	728·3	Di	Strong.
2420	679·3	679·4	Di	Scarcely perceptible.
2568	591·5	591·5	Di	Faint, broad.
2595	579·6	579·2	Di	Strong.
2604	575·8	575·4	Di	Rather strong.
2712	531·6	531·3	Di	Scarcely visible.
2747	521·6	521·5	Di	Rather strong and definite.
2780	512·5	512·2	Di	Faint, broad, misty.
2887	482·5	482·0	Di	Very sharp and intense, but narrow.
2943	469·4	469·0	Di	Rather strong.
3076	444·2	444·7	Di	Very strong.

VII. *a. Fergusonite from Arendal.*

Position of maximum darkness.				Intensity of Bands in Spectra of Fractions.				
Position of Telescope-drum.	Wave-length.	Wave-lengths formerly observed.	For.	Fraction I.	Fraction II.	Fraction III.	Fraction IV.	Fraction V.
2354	728·3	728·3	Di	Strong.	Rather strong.	Faint.	Extremely faint.	—
2382	707·5	708·2	Di	Extremely faint.	—	—	—	—
2415	683·2	684·0	Tm	—	—	—	—	—
2420	679·3	679·4	Di	Very faint.	Faint.	Faint.	Faint.	Very faint.
2456	654·2	654·7	Er	Stronger.	Strong.	Strong.	Strong.	Rather strong.
2567	592·0	591·5	Di	Extremely faint.	Extremely faint.	—	—	—
2595	579·6	579·2	Di	Very strong.	Strong.	Very faint.	—	—
2606	575·0	575·4	Di	Strong.	Rather faint.	Extremely faint.	—	—
2682	542·6	542·6	X	Faint.	$\lambda=536{\cdot}3$ stronger than $\lambda=542{\cdot}6$. Both bands > in I.	$\lambda=536{\cdot}3$ stronger than $\lambda=542{\cdot}6$.	$\lambda=536{\cdot}3 >$ $\lambda=542{\cdot}6$; both stronger than III.	As in IV.
2699	535·3	536·3	X	Rather strong.				
2740	523·6	523·1	Er	Strong.	Very strong.	Very strong.	Strong.	Medium strong.
2747	521·6	521·5	Di	Strong, weaker than $\lambda=523{\cdot}1$.	Strong.	Strong.	Medium strong.	Faint.
2782	512·0	512·2	Di	Faint.	Very faint.	—	—	—
2872	485·9	485·5	X	Rather strong.	Strong.	Strong.	Strong.	Stronger than $\lambda=536{\cdot}3$.
2920	474·9	474·5	X	Strong as $\lambda=536{\cdot}3$.	Weaker than $\lambda=536{\cdot}3$.	Rather faint.	Extremely faint.	Scarce visible.
2943	469·4	469·0	Di	Extremely faint.	Scarcely visible.	Extremely faint.	Extremely faint.	—
2974	46·3	463·2	Sm	Very faint.	Extremely faint.	—	—	—
3030	452·3	453—449	X	Very strong.	Strongest line of the whole spectrum.	As in II.	As in II.	As in II.
3074	444·6	444·7	D	Faint.	Faint.	Very faint.	Very faint.	Extremely faint.
3165	428·5	428·5	X	Very faint.	Faintest of all X lines of this spectrum.	Very faint.	Extremely faint.	—
3240	417·3	416·7	Sm	Very strong.	Strong.	Rather strong.	Medium strong.	Rather strong.

VIII. *b. Fergusonite from Ytterby.*

Observed position of maximum darkness.		Wave-lengths formerly observed.	For.	Intensities of bands.
Position of Telescope-drum.	Wave-length observed.			
2353	729·0	728·3	Di	Rather strong.
2420	679·4	679·4	Di	Extremely faint.
2456	654·2	654·7	Er	Rather strong.
2480	640·6	640·4	X	Rather faint.
2505	626·1	626·1	Di	Extremely faint.
2567	592·0	591·5	Di	Very faint.
2595	579·6	579·2	Di	Very strong.
2606	575·0	574·4	Di	Strong.
2682	542·6	542·6	X	Rather strong.
2699	535·3	536·3	X	As strong as foregoing.
2705	533·6	—	(?)	Faint, but well defined.
2740	523·6	523·1	Er	Very strong.
2747	521·6	521·5	Di	Strong.
2782	512·1	512·2	Di	Faint.
2872	485·9	485·5	X	Strong.
2920	474·9	474·5	X	Very faint.
2943	469·4	469·0	Di	Scarcely perceptible.
2974	462·3	463·2	Sm	Very faint.
3023	452·6	453—449	X	Very strong; strongest line of spectrum.
3076	444·2	444·7	Di	Very faint.
3163	428·9	428·5	X	Faint.
3240	417·3	416·7	Sm	Strong.

tions of the twelve fractions have very different spectra, and it is interesting to see how the relative intensity of the absorption-bands fluctuates in the spectra of the several fractions. From the following tables it is apparent that several bodies, hitherto regarded as elementary, consist of several components (See Table VII.).

The earths which had been obtained from 1½ kilo. Fergusonite from Ytterby were not further separated by fractionated decomposition of the nitrates, but were at once examined in a nitric solution (See Table VIII.).

In the spectrum of the Fergusonite from Ytterby there are several lines of didymium and of Soret's X, which

a. Fergusonite from Arendal (continued).

Intensity of Bands in Spectra of Fractions.

Fraction VI.	Fraction VII.	Fraction VIII.	Fraction IX.	Fraction X.	Fraction XI.	Fraction XII.
—	—	—	—	—	—	—
—	—	—	—	—	—	—
Faint.	Stronger than in VI.	Rather strong.	Rather strong.	Weaker.	Faint.	Scarce visible.
—	—	—	—	—	—	—
Rather faint.	Rather faint.	As in VII.	As in VII.	Weaker.	Very faint.	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
Rather faint; $\lambda = 536{\cdot}3$ rather stronger than $\lambda = 542{\cdot}3$	Both X lines equally strong.	$\lambda = 542{\cdot}6$ rather stronger than $\lambda = 536{\cdot}3$	$\lambda = 542{\cdot}6$ still stronger than $\lambda = 536{\cdot}3$; both lines faint.	Very faint.	Extremely faint.	—
				—	—	—
Rather strong.	Rather strong.	Rather strong.	Rather faint.	Faint.	Very faint.	Rather stronger than the Tm line of this fraction.
Faint.	Faint.	Very faint.	Very faint.	—	—	—
—	—	—	—	—	—	—
Rather strong.	Rather strong.	Rather strong.	Rather strong.	Fainter.	Faint.	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
Strongest line of spectrum.	As in VI.	As in VI.	As in VI.	Fainter.	Faint broad band.	—
Extremely faint.	Extremely faint.	Extremely faint.	—	—	—	—
—	—	—	—	—	—	—
Very faint.	Very faint.	—	—	—	—	—

could not be detected in the spectrum of the Fergusonite of Arendal. On the other hand, there were found in the material from Arendal considerable quantities of thulium, which was not observed in the Fergusonite of Ytterby. In the spectrum of the earths of the latter mineral there was seen a line at $\lambda = 533{\cdot}6$, which was otherwise found only in the absorption spectrum of the euxenite earths of Hitterö, though it could not be identified with any of the lines characteristic of the nitrates of the rare earths.

(To be continued).

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT.

Fellow of the American Association for the Advancement of Science; Member of the Academy of Natural Sciences, Philadelphia; of the Berliner Chemische Gesellschaft, &c., &c.

Alcoholic Extracts.

Extract (1), *Bark of the Root.*

The residual powder from the ether extraction was dried, and replaced in the percolator. The maceration was conducted at the boiling temperature of alcohol. Squibb's stronger alcohol was used. A dark red-coloured liquid was extracted. It was neutral in reaction with litmus. The *alcoholic extract* was evaporated in a current of carbonic acid. The *residue* was non-crystalline and of a red colour. A definite volume of the *alcoholic extract* was evaporated, dried until the weight remained constant, and the *residue* incinerated in a weighed platinum dish and the ash estimated.

I.

Total Solids.

Alcoholic residue dried at 100° C.	.. ..	9·25 per cent
" " " 110° C.	.. ..	9·25 "
ash	.. ..	0·2 "

The *alcoholic residue* was treated with distilled water, and a definite volume of the extract was evaporated, dried, and weighed. The *alcoholic residue* insoluble in water was treated with water containing ammonia (one part in fifty). This ammoniacal extract was evaporated with excess of acetic acid, and the residue rinsed with a little water on a filter, dried, and weighed. The dried aqueous extract insoluble in ammonia was then estimated.

II.

Distilled water residue	.. ..	3·22 per cent.
Ammonia " "	.. ..	5·43 "
Insoluble " "	.. ..	0·60 "
Total solids	.. ..	9·25 "

The aqueous extract from the *alcoholic residue* was studied as follows: It was not coloured by a ferroso-ferric salt nor precipitated by gelatin and alum solutions, showing absence of gallic acid and tannin. A portion of the aqueous extract was acidified with sulphuric acid and agitated successively with petroleum spirit, benzol chloroform, and amyl alcohol. The acidified liquid was rendered alkaline by ammonia and agitated with the solvents in the same order. Petroleum spirit removed from the acidified solution traces of an amorphous residue,

* Reprinted from the *Transactions of the American Philosophical Society.*

soluble in sulphuric acid and caustic soda. Benzol and chloroform separated no substances from the solution. As the amyl alcohol solution was evaporating white needle-shaped crystals were seen floating in the liquid. On drying the residue they were decomposed and melted, leaving a dark-coloured liquid. Several attempts were made to dry these crystals, without success. A few of the crystals were recovered from the solution, and tested for alkaloids; no reactions were obtained with the usual reagents for them.

Glucose was estimated from the aqueous extract. The liquid was heated over a water-bath with Fehling's solution, and the precipitated red cuprous oxide was thrown upon a weighed filter, dried, and incinerated. The glucose was estimated gravimetrically by calculating the amount of cupric oxide. It yielded 0·619 per cent. A portion of the aqueous extract was boiled with acid, neutralised, and heated over a water-bath with Fehling's solution to calculate, by difference, saccharose or other reducible compounds, and by this method 0·18 per cent was obtained.

The *alcoholic extract* was described as being deeply coloured. This colouring principle* was completely precipitated by sub-acetate of lead. The lead precipitate was collected on a filter, suspended in water, and decomposed by sulphuretted hydrogen, filtered, and the filtrate freed from all odour. It was allowed to evaporate slowly over sulphuric acid. The residue was a brownish grey mass, interpersed with fine crystals which radiated from a nucleus. The mass was weighed and gave 3·27 per cent of solids. Another portion of the *alcoholic extract* was agitated with water and acetic ether. The colouring matter was taken up by the acetic ether, and on evaporating a red-coloured substance was recovered. It was dried and weighed, yielding 2·2 per cent. This red-coloured residue was perfectly soluble in cold water. This solution was tested with the following reagents: It gave with potassium bichromate a creamy-coloured precipitate; ferric chloride, a yellowish green precipitate; ferrous sulphate, a reddish brown precipitate; stannous chloride, no precipitate, a yellow cloudy liquid; alum, a cloudy solution; neutral acetate of lead, a slight precipitate. The red colour of the colouring matter was brought out on addition of alkalies. It was destroyed by acids.

Extract (2), *Wood of the Root.*

The residual powder from the ether treatment was dried and macerated with Squibb's stronger alcohol. The *alcoholic extract* was neutral in reaction; when warm it was a clear reddish golden-coloured liquid. On cooling, a creamy-white solid settled at the bottom of the flask. This substance was soluble in water, and was identified as saponin by the usual tests for it. A definite volume of the *alcoholic extract* was evaporated in a current of carbonic acid, dried, and weighed. The residue was incinerated in a weighed platinum crucible for the ash determination.

Total Solids.

Alcoholic residue dried at 100° C.	14·3 per cent.
,, ,, ,, 110° C.	14·3 ,,
ash	0·1 ,,

The *alcoholic residue* was treated with cold water, in which it was soluble. A cloudy solution was formed, and on shaking, it became frothy, and presented the appearance of an emulsion. It was allowed to stand for several days to see if the resinous matter separated, but the emulsion was permanent, as no separation had taken place. The emulsified liquid was agitated with acetic ether, and this solvent readily separated most of the resin from the aqueous portion. The water extract was then evaporated to dryness and re-dissolved in water. Gelatin and alum solution did not precipitate the extract, showing absence of tannin; no colouration with iron salts, absence of gallic acid; negative results followed tests for alkaloids; the aqueous extract was boiled with potash and no ammonia fumes were formed; adding gold chloride, and potassio-mercuric iodide solutions to the extract gave no precipitate. A measured portion of the aqueous extract was acidified with sulphuric acid, and agitated successively with petroleum spirit, benzol, and chloroform. The solvents were evaporated; petroleum spirit removed 0·01 per cent of a resinous substance, imperfectly soluble in cold and boiling aqueous alkalies, dissolved by sulphuric acid with a red colouration; chloroform left a brownish residue which, on weighing, yielded 0·4 per cent. This residue was moistened with a few drops of concentrated sulphuric acid, and changed to a red-violet colour characteristic of saponin.

A certain portion of the aqueous extract was rendered alkaline, and heated over a water-bath with Fehling's solution. The precipitated copper was collected on a weighed filter, dried, and incinerated, and the glucose estimated gravimetrically from it. It yielded 1·592 per cent. Another portion of the aqueous extract was acidified, boiled, and potash added until the solution was alkaline to litmus paper, then the liquid was mixed with Fehling's solution and heated over a water-bath. The percentage of saccharose or other substances which reduced the copper was calculated by difference. It amounted to 0·929 per cent.

The resin separated by acetic ether was an opaque substance, greenish yellow in colour, and insoluble in ether. The resin was dissolved in water and frothed on shaking. The emulsion in this case was not quite so permanent, as a slight resinous sediment settled after a time, possibly due to changes in the resin through oxidation.

Extract (3), *the Green Part of the Leaf.*

The dried residual powder was macerated by the aid of heat with Squibb's stronger alcohol. When warm the *alcoholic extract* was clear, but on cooling the solution became cloudy, and a creamy-white fine precipitate settled. The *alcoholic extract* was neutral in reaction. It was evaporated in a current of carbonic acid, dried, and weighed. A certain part of the residue was incinerated and the ash determined.

Total Solids.

Alcoholic residue dried at 100° C.	3·80 per cent.
,, ,, ,, 110° C.	3·80 ,,
,, ash	0·15 ,,

The *alcoholic residue* was treated with cold distilled water. It had a slightly acid reaction with litmus. An emulsion was formed on the addition of water to the *alcoholic residue*. A measured quantity of it was evaporated, dried, and weighed. It amounted to 3·4 per cent; 0·4 per cent of the *alcoholic residue* was insoluble in water. Tannin, gallic acid, and alkaloids were tested for and with negative results.

The liquid from the aqueous treatment of the *alcoholic residue* was rendered alkaline, and boiled with Fehling's solution, and there was no reduction. Bœttger's bismuth test was also tried and with negative results. The aqueous portion was boiled with acid and examined in the usual way for glucosides; the results were negative.

One volume of the aqueous solution was mixed with three volumes of stronger alcohol. It was placed on ice, and after some time a white precipitate formed. The precipitate was collected and dissolved in water. It frothed on shaking. On addition of a concentrated solution of caustic baryta, a creamy-white precipitate of saponin-baryta was obtained. Sulphuric acid gave the usual red-violet colour reaction with the precipitate from the alcoholic aqueous solution.

The method of successive agitation of an aqueous extract with solvents already described was followed. Petroleum spirit on evaporating left a resinous substance. The residue separated by chloroform from an acidified solution

* A red crystalline colouring matter. *Science*, September 11, 1885

was a brownish coloured substance. It was soluble in water, and frothed on shaking. It was coloured red violet by sulphuric acid, and the aqueous solution was precipitated by barium hydrate. Chloroform separated a brownish solid from an alkaline aqueous solution. It was precipitated by barium, coloured red-violet by sulphuric acid, and its aqueous solution frothed on shaking. This brownish residue was identified as saponin.

Extract (4), *the Yellow Base of the Leaf.*

The residual powder, dried from all traces of ether, was macerated with hot alcohol. The *alcoholic extract* was a currant-coloured liquid, and slightly acid in reaction. The liquid became clear on standing, and a creamy-white solid, identified as saponin, separated from it. The *alcoholic extract* was evaporated, dried, and weighed, and the ash of the residue was estimated.

Total Solids.

Alcoholic residue dried at 100° C.	4·30	per cent.
,, ,, ,, 110° C.	4·30	,,
,, ,, ash	0·05	,,

The *alcoholic residue* was treated with cold distilled water. The solution was slightly coloured, and faintly acid in reaction. The absence of gallic acid, tannin, and alkaloids was determined by negative results with iron salts, gelatin and alum solution, gold chloride and potassio-mercuric solutions. Acetate of lead caused no precipitation. Fehling's solution detected a trace of glucose.

An imperfect emulsion formed on adding water to the *alcoholic residue*. Upon standing, the resin settled; the liquid was filtered several times, and the greater part of the resin collected. It was an opaque reddish yellow coloured substance. It had the same melting-point (79° C.), solubilities, and physical appearance as the resin of *ether extract* (4). The resin was examined by Hirschsohn's scheme. It differed in character from the many resins described by that author, and it is proposed to name it pyrophæal.*

Pyrophæal was slightly soluble in ether and 95 per cent alcohol; soluble in benzol, chloroform, and acetic ether; incompletely soluble in cold absolute alcohol, amyl alcohol, carbon disulphide, and oil of turpentine. It was saponified with aqueous and alcoholic soda. The ethereal resin solution was cloudy. The alcoholic resin solution gave a precipitate with lead acetic which did not disappear on boiling; ferric chloride and aqueous ammonia formed turbid mixtures with it. The chloroform resin solution was not affected by bromine solution. The petroleum-ether-resin solution turned to a turbid mixture on adding iodine solution. Alcohol containing hydrochloric acid was not coloured by the resin. Sulphuric acid and alcohol gave a turbid brown mixture with it, and sodium carbonate solution was coloured pale brown when cold or on warming.

(To be continued).

NOTICES OF BOOKS.

Technical School and College Building: being a Treatise on the Design and Construction of Applied Science and Art Buildings, and their Suitable Fittings and Sanitation; with a Chapter on Technical Education. By Edward Cookworthy Robins, F.S.A. London: Whittaker and Co.

We have here an original, and we must say an exceedingly valuable, work, which we trust will meet with sufficient appreciation to remunerate the publishers for the very heavy expenditure they must have incurred in bringing it out. The changes which are taking place in the character of higher education involve a corresponding modification in the structure of school and college buildings. So long as instruction had to be given merely or mainly in words and abstractions, almost any kind of rooms would answer the purpose if only—which was not always the case—duly lighted, warmed, and ventilated. But so soon as *things* became the objects of study,—so soon as a thorough training in the natural and physical sciences was found to be necessary,—colleges had to be fitted with laboratories (chemical, physical, and biological), with museums, model-rooms, and a variety of other appliances. To contrive and arrange these with full regard both to efficiency and economy was found to be a task not within the scope of the ordinary architect. Here, therefore, is the *raison d'être* of Mr. Robins's work. He has made a careful study of the chief college buildings, technical schools, laboratories, &c., at home and abroad, of which he has given numerous plans, elevations, and sections, drawn to scale and accompanied with very full descriptions. Hence to the trustees or directors of colleges, &c., desirous of enlarging or re-modelling the working portions of their premises, as well as to their architects, the work will be simply priceless. In our opinion Mr. Robins merits the gratitude of all friends of higher education for the manner in which he has executed his task.

The third chapter, illustrated with ten elaborate plates in addition to woodcuts, gives an account of foreign buildings for science and art instruction. We note the expression "applied science" used by the author, which is not in all cases strictly correct, since some of the institutions figured and described are devoted to pure science, irrespective of any applications.

It may be instructive to consider the sums spent on the University of Strassburg,—quite a third-class city as regards its size and wealth. "Towards the total sum of £640,000 expended on this University up to 1885, the German Empire has contributed £190,000; of this sum £115,000 were spent on the Collegiate Palace. The Institute of Chemistry alone cost £35,000; the Institute of Physics, £29,150; the Institute of Botany, with its garden, £26,200; the Astronomical Observatory, £25,000; the Institute of Anatomy, £41,740; the Surgical Clinical Hospital, £26,500; the Institute of Physiological Chemistry, £16,000; and the Institute of Physiology, £13,500.

The Institutes of Geology, Zoology, and Meteorology have yet to be erected and fitted up. The cost of the library of 560,000 volumes is not included in the above estimates, and reached £71,400.

May we be permitted to say that, if we wish to be on an equal footing with Germany in the cultivation of science, we ought to have universities at least equally well equipped, in Liverpool, Manchester, Birmingham, Leeds, Sheffield, Newcastle-on-Tyne, Edinburgh, Glasgow, Dublin, Belfast, besides an institution in London of far greater calibre, and a vast development of the ancient universities of Oxford and Cambridge?

It is to be deplored that wealthy men in this country are willing to give thousands for the purposes of faction, rather than for institutions to promote the general prosperity of the country.

In Chapter IV. the author gives a corresponding account, on a still larger scale, of English laboratories, &c.

We next come to two chapters on the fittings required for applied science instruction buildings. These chapters will also be found exceedingly useful.

Chapters VII. and VIII. discuss the heating and ventilation of laboratories, &c. Chapter IX. treats of the planning of buildings for middle-class education generally, and Chapter X. deals with sanitary science in its relations to civil architecture.

The first two chapters of the work, however, have little connection with the building or fitting up of colleges or laboratories, but are devoted to a survey of English and foreign technical education, and to an analysis of the Second Report of the Royal Commissioners on Technical

* Pyrophæal. *Science*, September 11, 1885.

Education. In these chapters, which would require great space for full discussion, we find much that we can unhesitatingly approve, but also no little upon which we are compelled to pause.

The account given of the establishments for higher education in Germany is, so far as our own observation and the information at our command extend, very correct, But we find it strange that neither Mr. Robins himself nor the eminent authorities whom he cites seem to take into account the main differences between the German and the English systems of education, to the disadvantage, as it seems to us, of the latter. Germany is free from the vicious custom of payment by results, falsely so called, and from competitive examinations. Indeed in Germany examinations play a very much smaller part in education shan they do in England. The great object among German professors is to train their students for research, whilst the great object of the English "coach," or "grinder," is to make his pupils pass. Prof. Huxley's memorable dictum should never be forgotten. Said this eminent *savant*—"In these days we study not to know, but to pass, and consequently we pass and don't know." It is therefore with much regret that we see "payment by results" still recognised in the "recommendations" embodied in the "Second Report on Technical Education."

For the views cited in this second chapter Mr. Robins cannot be held responsible, and the value and utility of his work will be evident on careful inspection to every competent reader.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 4, July 25, 1887.

Fluorescences of Manganese and Bismuth. Remarks or Conclusions.—Lecoq de Boisbaudran.—The author specifies a number of conditions under which fluorescences are modified. He remarks that certain fluorescences, masked by others, may be detected either on heating the tube or by observing after the cessation of the current, or by modifying the intensity of the current.

Direct Preparation of Two Inactive Borneols, yielding, on Oxidation, Dextro- or Levo-Camphor.—Alb. Haller.—Borneols may be obtained by the hydrogenisation of camphors. They may be prepared either by the process of Berthelot, or by that of Baubigny, or by the method devised by Jackson and Mencke, and modified by Wallach. Whatever is the process of hydrogenisation employed, there has never been obtained a single stable camphol; it is always mixed with an unstable variety.

Action of Aniline upon Bibromised Diethyl-succinic Ether.—N. Lopatine.—The author boiled for twelve hours 10 parts of the above ether with 20 parts of aniline and 40 parts of alcohol at 95 per cent in a flask fitted with a reflux condenser. At the end of the reaction the mass solidifies. When cold it is treated with cold alcohol, which dissolves a part of the product with a deep brown colour. The residue is taken up in boiling alcohol, which deposits a new compound in long silky needles. The author is engaged with the further study of this compound.

Zeitschrift für Analytische Chemie. Vol. xxvi., Part 1.

Fat for Greasing the Edges of Beakers.—A. Gawalowski.—Instead of tallow, &c., the author recommends, in case of alkaline liquids, solid paraffin, and for solutions in ether, petroleum ether, or similar liquids, starch paste, gum-arabic, dextrine, &c. (We do not know who first proposed solid paraffin for greasing the lips of beakers, but it was in use in England seventeen years ago).

An Absorbent for Oxygen.—Otto Baron von der Pfordten.—From *Liebig's Annalen.*

Determination of Lithium with the Spectroscope.—Foehr.—H. Ballmann published a method in this *Journal* (xiv., p. 297), which appears to have been independently re-discovered by L. Bell (See *Am. Chem. Journal*, vii., 35, and *Berichte Deutsch. Chem. Gesellschaft*, xviii., 2897). Foehr modifies the original process of Ballmann by adding to a litre of distilled water a mille-normal solution by means of a burette until a drop of the mixture on a platinum wire shows the line L : α. If the same experiment is then conducted with the solution under examination, the proportion of lithium appears from the volume used.

Reactions of Indium.—Lecoq de Boisbaudran.—From the *Comptes Rendus.*

Electrolytic Quantitative Analysis.—A. Classen and R. Ludwig.—The authors separate antimony from arsenic as follows:—The mixture of both metals or their compounds is completely evaporated down with aqua regia, the residue is dissolved in 2 to 3 c.c. water, pure strong soda-lye is added in such a proportion that 1 grm. NaOH may be contained in the liquid, 60 c.c. of the sodium sulphide solution described in this *Zeitschrift* (xxv., 103) are added, and the process is continued exactly as described (p. 102) for separating antimony from tin. The separation of antimony from arsenic and tin can be effected in the same manner, especially if only the determination of the antimony is required. If the arsenic and tin are also to be determined the former must first be separated by Fischer's method modified by Hufschmidt. Classen and Ludwig separate mercury quantitatively from a nitric solution by means of a current which yields in the voltameter 0·5 to 1 c.c. of detonating gas per minute. The action must be continued twelve to sixteen hours at the common temperature. In the same solution mercury may be separated from the alkaline earths, chromium, aluminium, nickel, cobalt, iron, manganese, uranium, and cadmium. To the aqueous solution of the metallic salts, about 200 c.c. in volume, are added 2 c.c. of strong nitric acid, and the separation is effected as above described. The deposit is then repeatedly washed with cold water (without interrupting the current) until the liquid no longer reacts acid; it is next repeatedly washed with absolute alcohol and dried for a short time over sulphuric acid in the exsiccator. Mercury cannot be separated from bismuth in this manner. For the electrolytic determination of bismuth S. Eliasberg (*Berichte*) mixes the bismuth salt weighed in a tared platinum capsule with 10 c.c. of a solution of potassium oxalate (1 : 3), heats, and adds gradually solid ammonium oxalate until complete solution is effected. He dilutes to 150 c.c., heats to 70° to 80°, and exposes the solution at this temperature to a current so weak that a development of gas is scarcely perceived in the voltameter. Very suitable are two Meidinger elements, a resistance of about 60 ohms being introduced into the circuit. When the bulk of the metal has been deposited, after about sixteen hours pure oxalic acid is added until the reaction is acid and the electrolysis is continued. After twenty-four hours a few drops of the solution are tested for bismuth with hydrogen sulphide. If it is absent the current is interrupted and the deposit is washed with water. The metal adheres so firmly that no loss is experienced in washing. The results are, however, often too high in consequence of a partial oxidation of the bismuth. Hence it is recommended to dissolve the metal in a little strong nitric acid, to evaporate the solution to dryness on the water-bath, converting the bismuth nitrate into oxide by ignition. In this manner bismuth may be separated from zinc, nickel, cobalt, and uranium, but not from iron. E. F. Smith and

E. B. Knerr have continued the experiments of H. Wiley Thomas and E. F. Smith on the electrolytic separation of bismuth and iron in a sulphuric solution (*Zeitschrift*, xxiii., 412). In this manner they effected the separation of bismuth from iron. By means of a current yielding 3 c.c. detonating gas per minute, they precipitated 0·1542 grm. bismuth in presence of 0·0230 grm. iron in three hours, the volume of liquid being 150 c.c. containing 3 c.c. of sulphuric acid. In the same manner they effected the separation of bismuth from aluminium, chromium, iron, cobalt, nickel, cadmium, manganese, uranium, and zinc.

Separation of the Primary from the Secondary and Tertiary Amines.—A. Michael.—The author utilises the property of the former, when heated with citraconic acid in aqueous solution, to give insoluble precipitates of anilide or analogous compounds. The secondary and tertiary amines form, under similar circumstances, no insoluble compounds.

Simultaneous Determination of Carbon, Hydrogen, and Nitrogen.—P. Jannasch and V. Meyer.—From *Liebig's Annalen*.

Determination of Carbon in Cellulose.—C. F. Cross and E. J. Bevan.—From the CHEMICAL NEWS.

Determination of Nitrogen present as Nitric Acid along with Organic Matter.—Max Jodlbauer.—The author has examined Asboth's modification of the Kjeldahl process, and finds the results uniformly below the truth. Instead of the benzoic acid proposed by Asboth he therefore uses an addition of phenol, and obtains thus concordant results.

Specific Gravity of Pure Alcohol and of its Admixtures with Water.—E. R. Squibb, E. H. Squibb, and C. F. Squibb.—From the CHEMICAL NEWS.

Determination of Tannin.—H. Dieudonné.—The author has taken up Hammer's method and determines the specific gravity of the solution before and after treatment with powdered hide by means of a special hydrometer, graduated in hundredth parts of a degree B.—(*Chemiker Zeitung*).

Blue Bread.—K. B. Lehmann.—Seeds of Rhinanthus and of Melampyrum, if ground up with grain, give a blue colour to bread. Rhinanthocyan, the pigment of the former, gives a spectrum very similar to that of indigo, which the pigment resembles also in being soluble in chloroform, though not in ether.

Coloured Sausage.—Otto Schweissinger.—No colour could be extracted either with ethylic or amylic alcohol. Red particles, approaching magenta in their shade, were discovered on microscopic examination.

Mineral Acids in Vinegar.—A. Foehring.—The author adds a fragment of hydrated zinc sulphide. In presence of mineral acids sulphuretted hydrogen is evolved.

Experimental Researches on Petroleum.—W. Thörne.—From the *Chemiker Zeitung*.

Qualitative Analysis of the Colours occurring in Commerce.—O. N. Witt.—The substance of this paper will be inserted at the earliest possible opportunity.

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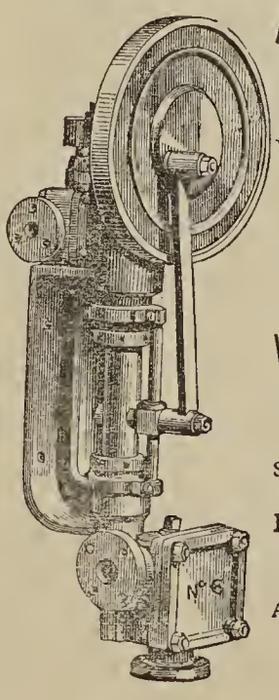

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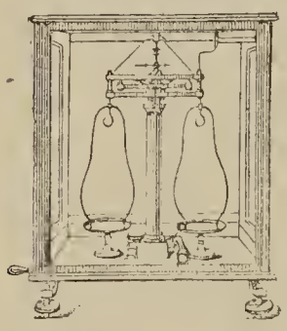

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CORNISH MINERALS.—In a trip of about two weeks through Cornwall we recently purchased several thousand specimens, including some old collections and some recent discoveries. Among them were Cronstedtite (said by COLLINS to be rare), Ludlamite, Torbernite, Chalcophyllite Redruthite, Scorodite, Olivenite, Liebethenite, Lirocnite, Cassiterite, Clinoclase, Chalybite in fine Crystals, Cuprite, Bornite Crystals, Enysite, Liebethenite, Henwoodite, Langite, Tenantite, Pharmacosiderite, and many other well-crystallised Minerals in Specimens from 6*d.* up. These are all on private view.

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THE CHEMICAL NEWS.

Vol. LVI. No. 1449.

BRITISH ASSOCIATION
FOR THE
ADVANCEMENT OF SCIENCE.

Manchester Meeting, September 1, 1887.

INAUGURAL ADDRESS OF THE PRESIDENT,

Sir Henry E. Roscoe, M.P., D.C.L., LL.D., Ph.D., F.R.S., V.P.C.S.

Manchester, distinguished as the birthplace of two of the greatest discoveries of modern science, heartily welcomes to-day, for the third time, the members and friends of the British Association for the Advancement of Science.

On the occasion of our first meeting in this city in the year 1842 the President, Lord Francis Egerton, commenced his address with a touching allusion to the veteran of science, John Dalton, the great chemist, the discoverer of the laws of chemical combination, the framer of the atomic theory upon which the modern science of chemistry may truly be said to be based. Lord Francis Egerton said:—"Manchester is still the residence of one whose name is uttered with respect wherever science is cultivated, who is here to-night to enjoy the honours, due to a long career of persevering devotion to knowledge, and to receive from myself, if he will condescend to do so, the expression of my own deep personal regret that increase of years, which to him up to this hour has been but increase of wisdom, should have rendered him in respect of mere bodily strength unable to fill on this occasion an office which in his case would have received more honour than it could confer. I do regret that any cause should have prevented the present meeting in his native town from being associated with the name"—and here I must ask you to allow me to exchange the name of Dalton in 1842 for that of Joule in 1887, and to add again in the words of the President of the former year that I would gladly have served as a doorkeeper in any house where Joule, the father of science in Manchester, was enjoying his just pre-eminence.

For it is indeed true that the mantle of John Dalton has fallen on the shoulders of one well worthy to wear it, one to whom science owes a debt of gratitude not less than that which it willingly pays to the memory of the originator of the atomic theory. James Prescott Joule it was who, in his determination of the mechanical equivalent of heat, about the very year of our first Manchester meeting, gave to the world of science the results of experiments which placed beyond reach of doubt or cavil the greatest and most far-reaching scientific principle of modern times, namely, that of the conservation of energy. This, to use the words of Tyndall, is indeed a generalisation of conspicuous grandeur fit to take rank with the principle of gravitation, more momentous, if that be possible, combining as it does the energies of the material universe into an organic whole, and enabling the eye of science to follow the flying shuttles of the universal power as it weaves what the Erdgeist in "Faust" calls "the living garment of God."

It is well, therefore, for us to remember, in the midst of the turmoil of our active industrial and commercial life, that Manchester not only well represents the energy of England in these practical directions, but that it possesses even higher claims to our regard and respect as being the seat of discoveries of which the value, not only to pure science, is momentous, but which also lie at the foundation of all our material progress and all our industrial success. For without a knowledge of the laws of chemical combination all the marvellous results with which modern industrial chemistry has astonished the world could not have been achieved, whilst the knowledge of the quantitative relations existing between the several forms of energy, and the possibility of expressing their amount in terms of ordinary mechanics, are matters which now constitute the life-breath of every branch of applied science. For example, before Dalton's discovery every manufacturer of oil of vitriol—a substance now made each week in thousands of tons within a few miles of this spot—every manufacturer had his own notions of the quantity of sulphur which he ought to burn in order to make a certain weight of sulphuric acid, but he had no idea that only a given weight of sulphur can unite with a certain quantity of oxygen and of water to form the acid, and that an excess of any one of the component parts was not only useless but harmful. Thus, and in tens of thousands of other instances, Dalton replaced rule of thumb by scientific principle. In like manner the applications of Joule's determination of the mechanical equivalent of heat are even more general; the increase and measurement of the efficiency of our steam engines and the power of our dynamos are only two of the numerous examples which might be adduced of the practical value of Joule's work.

If the place calls up these thoughts, the time of our meeting also awakens memories of no less interest, in the recollection that we this year celebrate the Jubilee of her Most Gracious Majesty's accession to the throne. It is right that the members of the British Association for the Advancement of Science should do so with heart and voice, for although science requires and demands no royal patronage, we thereby express the feeling which must be uppermost in the hearts of all men of science, the feeling of thankfulness that we have lived in an age which has witnessed an advance in our knowledge of nature, and a consequent improvement in the physical, and let us trust also in the moral and intellectual, well being of the people hitherto unknown; an age with which the name of Victoria will ever be associated.

To give even a sketch of this progress, to trace even in the merest outline the salient points of the general history of science during the fifty momentous years of her Majesty's reign, is a task far beyond my limited powers. It must suffice for me to point out to you, to the best of my ability, some few of the steps of that progress as evidenced in the one branch of science with which I am most familiar, and with which I am more closely concerned, the science of chemistry.

In the year 1837 chemistry was a very different science from that existing at the present moment. Priestley, it is true, had discovered oxygen, Lavoisier had placed the phenomena of combustion on their true basis, Davy had decomposed the alkalis, Faraday had liquefied many of the gases, Dalton had enunciated the laws of chemical combination by weight, and Gay-Lussac had pointed out the fact that a simple volumetric relation governs the combination of the gases. But we then possessed no knowledge of chemical dynamics, we were then altogether unable to explain the meaning of the heat given off in the act of chemical combination. The atomic theory was indeed accepted, but we were as ignorant of the mode of action of the atoms and as incapable of explaining their mutual relationship as were the ancient Greek philosophers. Fifty years ago, too, the connection existing between the laws of life, vegetable and animal, and the phenomena of inorganic chemistry, was ill understood. The idea that the functions of living beings are controlled by the same forces, chemical and physical, which regulate the changes occurring in the inanimate world, was then one held by only a very few of the foremost thinkers of the time. Vital force was a term in every-

one's mouth, an expression useful, as Goethe says, to disguise our ignorance, for—

Wo die Begriffe fehlen,
Da tritt ein Wort zur rechten Zeit sich ein.

Indeed the pioneer of the chemistry of life, Liebig himself, cannot quite shake himself free from the bonds of orthodox opinion, and he who first placed the phenomena of life on a true basis cannot trust his chemical principles to conduct the affairs of the body, but makes an appeal to vital force to help him out of his difficulties; as when in the body politic an unruly mob requires the presence and action of physical force to restrain it and to bring its members under the saving influence of law and order, so too, according to Liebig's views, in the body coporeal a continual conflict between the chemical forces and the vital power occurs throughout life, in which the latter, when it prevails, insures health and a continuance of life, but of which defeat insures disease or death. The picture presented to the student of to-day is a very different one. We now believe that no such conflict is possible, but that life is governed by chemical and physical forces, even though we cannot in every case explain its phenomena in terms of these forces; that whether these tend to continue or to end existence depends upon their nature and amount, and that disease and death are as much a consequence of the operation of chemical and physical laws as are health and life.

Looking back again to our point of departure fifty years ago, let us for a moment glance at Dalton's labours, and compare his views and those of his contemporaries with the ideas which now prevail. In the first place it is well to remember that the keystone of his atomic theory lies not so much in the idea of the existence and the indivisible nature of the particles of matter—though this idea was so firmly implanted in his mind that, being questioned on one occasion on the subject, he said to his friend the late Mr. Ransome, "Thou knowst it must be so, for no man can split an atom"—as in the assumption that the weights of these particles are different. Thus, whilst each of the ultimate particles of oxygen has the same weight as every other particle of oxygen, and each atom of hydrogen, for example, has the same weight as every other particle of hydrogen, the oxygen atom is sixteen times heavier than that of hydrogen, and so on for the atoms of every chemical element, each having its own special weight. It was this discovery of Dalton, together with the further one that the elements combine in the proportions indicated by the relative weights of their atoms or in multiples of these proportions, which at once changed chemistry from a qualitative to a quantitative science, making the old invocation prophetic, "Thou hast ordered all things in measure and number and weight."

The researches of chemists and physicists during the last fifty years have not only strengthened but broadened the foundations of the great Manchester philosopher's discoveries. It is true that his original numbers, obtained by crude and inaccurate methods, have been replaced by more exact figures, but his laws of combination and his atomic explanation of those laws stand as the great bulwarks of our science.

On the present occasion it is interesting to remember that within a stone's-throw of this place is the small room belonging to our Literary and Philosophical Society which served Dalton as his laboratory. Here with the simplest of all possible apparatus—a few cups, penny ink bottles, rough balances, and self-made thermometers and barometers—Dalton accomplished his great results. Here he patiently worked, marshalling facts to support his great theory, for as an explanation of his laborious experimental investigations the wise old man says:—"Having been in my progress so often misled, by taking for granted the results of others, I have determined to write as little as possible but what I can attest by my own experience." Nor ought we when here assembled to forget that the last three of Dalton's experimental essays—one of which, on a new method of measuring water of crystallisation, contained more than the germ of a great discovery—were communicated to our Chemical Section in 1842, and that this was the last memorable act of his scientific life. In this last of his contributions to science, as in his first, his method of procedure was that which has been marked out as the most fruitful by almost all the great searchers after nature's secrets, namely the assumption of a certain view as a working hypothesis, and the subsequent institution of experiment to bring this hypothesis to a test of reality upon which a legitimate theory is afterwards to be based. "Dalton," as Henry well says, "valued detailed facts mainly, if not solely, as the stepping-stones to comprehensive generalisations."

Next let us ask what light the research of the last fifty years has thrown on the subject of the Daltonian atoms: first, as regards their size; secondly, in respect to their indivisibility and mutual relationships; and thirdly, as regards their motions.

As regards the size and shape of the atoms, Dalton offered no opinion, for he had no experimental grounds on which to form it, believing that they were inconceivably small and altogether beyond the grasp of our senses aided by the most powerful appliances of art. He was in the habit of representing his atoms and their combinations diagrammatically as round discs or spheres made of wood, by means of which he was fond of illustrating his theory. But such mechanical illustrations are not without their danger, for I well remember the answer given by a pupil to a question on the atomic theory: "Atoms are round balls of wood invented by Dr. Dalton." So determinedly indeed did he adhere to his mechanical method of representing the chemical atoms and their combinations that he could not be prevailed upon to adopt the system of chemical formulæ introduced by Berzelius and now universally employed. In a letter addressed to Graham in April, 1837, he writes: "Berzelius's symbols are horrifying. A young student in chemistry might as soon learn Hebrew as make himself acquainted with them." And again: "They appear to me equally to perplex the adepts in science, to discourage the learner, as well as to cloud the beauty and simplicity of the atomic theory."

But modern research has accomplished, as regards the size of the atom, at any rate to a certain extent, what Dalton regarded as impossible. Thus in 1865 Loschmidt, of Vienna, by a train of reasoning which I cannot now stop to explain, came to the conclusion that the diameter of an atom of oxygen or nitrogen was 1-10,000,000th of a centimetre. With the highest known magnifying power we can distinguish the 1-40,000th part of a centimetre; if now we imagine a cubic box each of whose sides has the above length, such a box when filled with air will contain from 60 to 100 millions of atoms of oxygen and nitrogen. A few years later William Thomson extended the methods of atomic measurement, and came to the conclusion that the distance between the centres of contiguous molecules is less than 1-5,000,000th and greater than 1-1,000,000,000th of a centimetre; or, to put it in language more suited to the ordinary mind, Thomson asks us to imagine a drop of water magnified up to the size of the earth, and then tells us that the coarseness of the graining of such a mass would be something between a heap of small shot and a heap of cricket balls. Or again, to take Clifford's illustration, you know that our best microscopes magnify from 6000 to 8000 times; a microscope which would magnify that result as much again would show the molecular structure of water. Or again, to put it in another form, if we suppose that the minutest organism we can now see were provided with equally powerful microscopes, these beings would be able to see the atoms.

Next, as to the indivisibility of the atom, involving also the question as to the relationships between the atomic weights and properties of the several elementary bodies.

Taking Dalton's aphorism, "Thou knowst no man can split an atom," as expressing the view of the enunciator

of the atomic theory, let us see how far this idea is borne out by subsequent work. In the first place, Thomas Thomson, the first exponent of Dalton's generalisation, was torn by conflicting beliefs until he found peace in the hypothesis of Prout, that the atomic weights of all the so-called elements are multiples of a common unit, which doctrine he sought to establish, as Thorpe remarks, by some of the very worst quantitative determinations to be found in chemical literature, though here I may add that they were not so incorrect as Dalton's original numbers.

Coming down to a somewhat later date, Graham, whose life was devoted to finding what the motion of an atom was, freed himself from the bondage of the Daltonian aphorism, and defined the atom not as a thing which cannot be divided, but as one which has not been divided. With him, as with Lucretius, as Angus Smith remarks, the original atom may be far down.

But speculative ideas respecting the constitution of matter have been the scientific relaxation of many minds from olden time to the present. In the mind of the early Greek the action of the atom as one substance taking various forms by unlimited combinations was sufficient to account for all the phenomena of the world. And Dalton himself, though upholding the indivisibility of his ultimate particles, says :—"We do not know that any of the bodies denominated elementary are absolutely indecomposable." Again Boyle, treating of the origin of form and quality, says :—"There is one universal matter common to all bodies—an extended divisible and impenetrable substance." Then Graham in another place expresses a similar thought when he writes : "It is conceivable that the various kinds of matter now recognised as different elementary substances may possess one and the same ultimate or atomic molecules existing in different conditions of movement. The essential unity of matter is an hypothesis in harmony with the equal action of gravity upon all bodies."

What experimental evidence is now before us bearing upon these interesting speculations? In the first place, then, the space of fifty years has completely changed the face of the inquiry. Not only has the number of distinct well-established elementary bodies increased from fifty-three in 1837 to seventy in 1887 (not including the *twenty* or more new elements recently said to have been discovered by Krüss and Nilson in certain rare Scandinavian minerals), but the properties of these elements have been studied, and are now known to us with a degree of precision then undreamt of. So that relationships existing between these bodies which fifty years ago were undiscernible are now clearly manifest, and it is to these relationships that I would for a moment ask your attention. I have already stated that Dalton measured the relative weights of the ultimate particles by assuming hydrogen as the unit, and that Prout believed that on this basis the atomic weights of all the other elements would be found to be multiples of the atomic weight of hydrogen, thus indicating that an intimate constitutional relation exists between hydrogen and all the other elements.

Since the days of Dalton and Prout the truth or otherwise of Prout's law has been keenly contested by the most eminent chemists of all countries. The inquiry is a purely experimental one, and only those who have a special knowledge of the difficulties which surround such inquiries can form an idea of the amount of labour and self-sacrifice borne by such men as Dumas, Stas, and Marignac in carrying out delicate researches on the atomic weights of the elements. What is, then, the result of these most laborious experiments? It is that, whilst the atomic weights of the elements are not exactly either multiples of the unit or of half the unit, many of the numbers expressing most accurately the weight of the atom approximate so closely to a multiple of that of hydrogen that we are constrained to admit that these approximations cannot be a mere matter of chance, but that some reason must exist for them. What that reason is, and why a close approximation and yet something short of absolute identity exists, is as yet hidden behind the veil; but who is there that doubts that when this Association celebrates its centenary this veil will have been lifted and this occult but fundamental question of atomic philosophy shall have been brought into the clear light of day?

But these are by no means all the relationships which modern science has discovered with respect to the atoms of our chemical elements. So long ago as 1829 Döbereiner pointed out that certain groups of elements exist presenting in all their properties strongly marked family characteristics, and this was afterwards extended and insisted upon by Dumas. We find, for example, in the well-known group of chlorine, bromine, and iodine, these resemblances well developed, accompanied moreover by a proportional graduation in their chemical and physical properties. Thus, to take the most important of all their characters, the atomic weight of the middle term is the mean of the atomic weights of the two extremes. But these groups of triads appeared to be unconnected in any way with one another, nor did they seem to bear any relation to the far larger number of the elements not exhibiting these peculiarities.

Things remained in this condition until 1863, when Newlands threw fresh light upon the subject, showing a far-reaching series of relationships. For the first time we thus obtained a glance into the mode in which the elements are connected together, but, like so many new discoveries, this did not meet with the recognition which we now see it deserves. But whilst England thus had the honour of first opening up this new path, it is to Germany and to Russia that we must look for the consummation of the idea. Germany, in the person of Lothar Meyer, keeps, as it is wont to do, strictly within the limits of known facts. Russia, in the person of Mendelejeff, being of a somewhat more imaginative nature, not only seizes the facts which are proved, but ventures upon prophecy. These chemists, amongst whom Carnelley must be named, agree in placing all the elementary bodies in a certain regular sequence, thus bringing to light a periodic recurrence of analogous chemical and physical properties, on account of which the arrangement is termed the periodic system of the elements.

In order to endeavour to render this somewhat complicated matter clear to you, I may perhaps be allowed to employ a simile. Let us, if you please, imagine a series of human families, a French one, represented by Dumas, an English one, by name Newlands, a German one, the family of Lothar Meyer, and lastly a Russian one, that of Mendelejeff. Let us next imagine the names of these chemists placed in a horizontal line in the order I have mentioned. Then let us write under each the name of his father, and again, in the next lower line, that of his grandfather, followed by that of his great-grandfather, and so on. Let us next write against each of these names the names the number of years which has elapsed since the birth of the individual. We shall then find that these numbers regularly increase by a definite amount, *i.e.*, by the average age of a generation, which will be approximately the same in all the four families. Comparing the ages of the chemists themselves we shall observe certain differences, but these are small in comparison with the period which has elapsed since the birth of any of their ancestors. Now each individual in this series of family trees represents a chemical element; and just as each family is distinguished by certain idiosyncrasies, so each group of the elementary bodies thus arranged shows distinct signs of consanguinity.

But more than this, it not unfrequently happens that the history and peculiarities of some member of a family may have been lost, even if the memory of a more remote and more famous ancestor may be preserved, although it is clear that such an individual must have had an existence. In such a case Francis Galton would not hesitate from the characteristics of the other members to reproduce the physical and even the mental peculiarities of the missing

member; and should genealogical research bring to light the true personal appearance and mental qualities of the man, these would be found to coincide with Galton's estimate.

Such predictions and such verifications have been made in the case of no less than three of our chemical elements.

Thus, Mendelejeff pointed out that if, in the future, certain lacunæ in his table were to be filled, they must be filled by elements possessing chemical and physical properties which he accurately specified. Since that time these gaps have actually been stopped by the discovery of gallium by Lecoq de Boisbaudran, of scandium by Nilson, and of Germanium by Winkler, and their properties, both physical and chemical, as determined by their discoverers, agree absolutely with those predicted by the Russian chemist. Nay, more than this, we not unfrequently have had to deal with chemical foundlings, elements whose parentage is quite unknown to us. A careful examination of the personality of such waifs has enabled us to restore them to the family from which they have been separated by un unkind fate, and to give them that position in chemical society to which they are entitled.

These remarkable results, though they by no means furnish a proof of the supposition already referred to, viz., that the elements are derived from a common source, clearly point in this direction, and lend some degree of colour to the speculations of those whose scientific imagination, wearying of dry facts, revels in picturing to itself an elemental Bathybius, and in applying to the inanimate, laws of evolution similar to those which rule the animate world. Nor is there wanting other evidence regarding this inquiry, for here heat, the great analyser, is brought into court. The main portion of the evidence consists in the fact that distinct chemical individuals capable of existence at low temperatures are incapable of existence at high ones, but split up into new materials possessing a less complicated structure than the original. And here it may be well to emphasize the distinction which the chemist draws between the atom and the molecule, the latter being a more or less complicated aggregation of atoms, and especially to point out the fundamental difference between the question of separating the atoms in the molecule and that of splitting up the atom itself. The decompositions above referred to are, in fact, not confined to compound bodies, for Victor Meyer has proved, in the case of iodine that the molecule at high temperatures is broken to atoms, and J. J. Thomson has added to our knowledge by showing that this breaking up of the molecule may be effected not only by heat vibrations, but likewise by the electrical discharge at a comparatively low temperature.

How far, now, has this process of simplification been carried? Have the atoms of our present elements been made to yield? To this a negative answer must undoubtedly be given, for even the highest of terrestrial temperatures, that of the electric spark, has failed to shake any one of these atoms in two. That this is the case has been shown by the results with which spectrum analysis, that new and fascinating branch of science, has enriched our knowledge, for that spectrum analysis does give us most valuable aid in determining the varying molecular conditions of matter is admitted by all. Let us see how this bears on the question of the decomposition of the elements, and let us suppose for a moment that certain of our present elements, instead of being distinct substances, were made up of common ingredients, and that these compound elements, if I may be allowed to use so incongruous a term, are split up at the temperature of the electric spark into less complicated molecules. Then the spectroscopic examination of such a body must indicate the existence of these common ingredients by the appearance in the spark spectra of these elements of identical bright lines. Coincidences of this kind have indeed been observed, but on careful examination these have been shown to be due either to the presence of some one of the other elements as an impurity or to insufficient observational power. This absence of coincident lines admits, however, of two explanations—either that the elements are not decomposed at the temperature of the electric spark, or, what appears to me a much more improbabie supposition, each one of the numbers of bright lines exhibited by every element indicates the existence of a separate constituent, no two of this enormous number being identical.

Terrestrial analysis having thus failed to furnish favourable evidence, we are compelled to see if any information is forthcoming from the chemistry of the sun and stars. And here I would remark that it is not my purpose now to dilate on the wonders which this branch of modern science has revealed. It is sufficient to remind you that chemists thus have the means placed at their disposal of ascertaining with certainty the presence of elements well known on this earth in fixed stars so far distant that we are now receiving the light which emanated from them perhaps even thousands of years ago.

Since Bunsen and Kirchhoff's original discovery in 1859, the labours of many men of science of all countries have largely increase our knowledge of the chemical constitution of the sun and stars, and to no one does science owe more in this direction than to Lockyer and Huggins in this country, and to Young in the New England beyond the seas. Lockyer has of late years devoted his attention chiefly to the varying nature of the bright lines seen under different conditions of time and place on the solar surface, and from these observations he has drawn the inference that the matching observed by Kirchhoff between, for instance, the iron lines as seen in our laboratories and those visible in the sun, has fallen to the ground. He further explains this want of uniformity by the fact that at the higher transcendental temperatures of the sun the substance which we know here as iron is resolved into separate components. Other experimentalists, however, while accepting Lockyer's facts as to the variations in the solar spectrum, do not admit his conclusions, and would rather explain the phenomena by the well-known differences which occur in the spectra of all the elements when their molecules are subject to change of temperature or change of position.

Further, arguments in favour of this idea of the evolution of the elements have been adduced from the phenomena presented by the spectra of the fixed stars. It is well known that some of these shine with a white, others with a red, and others again with a blue light; and the spectroscope, especially under the hands of Huggins, has shown that the chemical constitution of these stars is different. The white stars, of which Sirius may be taken as a type, exhibit a much less complicated spectrum than the orange and the red stars; the spectra of the latter remind us more of those of the metalloids and of chemical compounds than of the metals. Hence it has been argued that in the white, presumably the hottest, stars a celestial dissociation of our terrestrial elements may have taken place, whilst in the cooler stars, probably the red, combination even may occur. But even in the white stars we have no *direct* evidence that a decomposition of any terrestrial atom has taken place; indeed we learn that the hydrogen atom, as we know it here, can endure unscathed the inconceivably fierce temperature of stars presumably many times more fervid than our sun, as Sirius and Vega.

Taking all these matters into consideration, we need not be surprised if the earthbound chemist should, in the absence of celestial evidence which is incontestable, continue, for the present at least, and until fresh evidence is forthcoming, to regard the elements as the unalterable foundation stones upon which his science is based.

Pursuing another line of inquiry on this subject, Crookes has added a remarkable contribution to the question of the possibility of decomposing the elements. With his well-known experimental prowess, he has discovered a new and beautiful series of phenomena, and has shown

that the phosphorescent lights emitted by certain chemical compounds, especially the rare earths, under an electric discharge in a high vacuum exhibit peculiar and characteristic lines. For the purpose of obtaining his material Crookes started from a substance believed by chemists to be homogeneous, such, for example, as the rare earth yttria, and succeeded by a long series of fractional precipitations in obtaining products which yield different phosphorescent spectra, although when tested by the ordinary methods of what we may term high temperature spectroscopy, they appear to be the one substance employed at the starting point. The other touchstone by which the identity, or otherwise, of these various products might be ascertained, viz., the determination of their atomic weights, has not, as yet, engaged Crookes's attention. In explanation of these singular phenomena, the discoverer suggests two possibilities. First, that the bodies yielding the different phosphorescent spectra are different elementary constituents of the substance which we call yttria. Or, if this be objected to because they all yield the same spark spectrum, he adopts the very reasonable view that the Daltonian atom is probably, as we have seen, a system of chemical complexity; and adds to this the idea that these complex atoms are not all of exactly the same constitution and weight, the differences, however, being so slight that their detection has hitherto eluded our most delicate tests, with the exception of this one of phosphorescence in a vacuum. To these two explanations, Marignac, in a discussion of Crookes's results, adds a third. It having been shown by Crookes himself that the presence of the minutest traces of foreign bodies produce remarkable alterations in the phosphorescent spectra, Marignac suggests that in the course of the thousands of separations which must be made before these differences become manifest, traces of foreign bodies may have been accidentally introduced, or, being present in the original material, may have accumulated to a different extent in the various fractions, their presence being indicated by the only test by which they can now be detected. Which of these three explanations is the true one must be left to future experiment to decide.

We must now pass from the statics to the dynamics of chemistry; that is, from the consideration of the atoms at rest to that of the atoms in motion. Here again we are indebted to John Dalton for the first step in this direction, for he showed that the particles of a gas are constantly flying about in all directions; that is, that gases diffuse into one another as an escape of coal gas from a burner, for example, soon makes itself perceptible throughout the room. Dalton, whose mind was constantly engaged in studying the molecular condition of gases, first showed that a light gas cannot rest upon a heavier gas as oil upon water, but that an interpenetration of each gas by the other takes place. It is, however, to Graham's experiments, made rather more than half a century ago, that we are indebted for the discovery of the law regulating these molecular motions of gases, proving that their relative rates of diffusion are inversely proportional to the square roots of their densities, so that oxygen being 16 times heavier than hydrogen, their relative rates of diffusion are 1 and 4.

But whilst Dalton and Graham indicated that the atoms are in a continual state of motion, it is to Joule that we owe the first accurate determination of the rate of that motion. At the Swansea Meeting in 1848, Joule read a paper before Section A on the Mechanical Equivalent of Heat on the Constitution of Elastic Fluids. In this paper Joule remarks whether we conceive the particles to be revolving round one another according to the hypothesis of Davy, or flying about in every direction according to Herapath's view, the pressure of the gas will be in proportion to the *vis viva* of its particles. "Thus it may be shown that the particles of hydrogen at the barometrical pressure of 30 inches at a temperature of 60° must move with a velocity of 6225·54 feet per second in order to produce a pressure of 14·714 lbs. on the square inch;" or, to put it in other words, a molecular cannonade or hailstorm of particles, at the above rate—a rate, we must remember, far exceeding that of a cannon ball—is maintained against the bounding surface.

We can, however, go a step further and calculate with Clerk Maxwell the number of times in which this hydrogen molecule, moving at the rate of 70 miles per minute, strikes against others of the vibrating swarm, and we learn that in one second of time it must knock against others no less than 18 thousand million times.

And here we may pause and dwell for a moment on the reflection that in nature there is no such thing as great or small, and that the structure of the smallest particle, invisible even to our most searching vision, may be as complicated as that of any one of the heavenly bodies which circle round our sun.

But how does this wonderful atomic motion affect our chemistry? Can chemical science or chemical phenomena throw light upon this motion, or can this motion explain any of the known phenomena of our science? I have already said that Lavoisier left untouched the dynamics of combustion. He could not explain why a fixed and unalterable amount of heat is in most cases emitted but in some cases absorbed when chemical combination takes place. What Lavoisier left unexplained Joule has made clear. On August 25, 1843, Joule read a short communication, I am glad to remember, before the Chemical Section of our Association, meeting that year at Cork, containing an announcement of a discovery which was to revolutionise modern science. This consisted in the determination of the mechanical equivalent of heat, in proving by accurate experiment that the expenditure of energy equal to that developed by the weight of 772 pounds falling through one foot at Manchester, the temperature of one pound of water can be raised 1° Fahrenheit. In other words, every change in the arrangement of the particles is accompanied by a definite evolution or an absorption of heat. In all such cases the molecular energy leaves the potential to assume the kinetic form, or *vice versâ*. Heat is evolved by the clashing of the atoms, and this amount is fixed and definite.

Thus it is to Joule we owe the foundation of chemical dynamics and the basis of thermal chemistry. As the conservation of mass or the principle of the indestructibility of matter forms the basis of chemical statics, so the principle of the conservation of energy* constitutes the foundation of chemical dynamics. Change in the form of matter and change in the form of energy are the universal accompaniments of every chemical operation. Here again it is to Joule we owe the proof of the truth of this principle in another direction, viz., that when electrical energy is developed by chemical change a corresponding quantity of chemical energy disappears. Energy is defined by Maxwell as the power of doing work, and work is the act of producing a change of configuration in a system in opposition to a force which resists that change. Chemical action produces such a change of configuration in the molecules. Hence, as Maxwell says, "a complete knowledge of the mode in which the potential energy of a system varies with the configuration would enable us to predict every possible motion of the system under the action of given external forces, provided we were able to overcome the purely mathematical difficulties of the calculation." The object of thermal chemistry is to measure these changes of energy by thermal methods, and to connect these with chemical changes, to estimate the attractions of the atoms and molecules to which the name of chemical affinity has been applied, and thus to solve the most fundamental problem of chemical science. How far has modern research approached the solution of this most difficult problem? How far can we answer the

* "The t energy of any material system is a quantity which can neither be increased nor diminished by any action between the parts of the system, though it may be transformed into any of the forms of which energy is susceptible."—Maxwell.

question, what is the amount of the forces at work in these chemical changes? What laws govern these forces? Well, even in spite of the results with which recent researches, especially the remarkable ones of the Danish philosopher Thomsen have enriched us, we must acknowledge that we are yet scarcely in sight of Maxwell's position of successful prediction. Thermal chemistry, we must acknowledge, is even yet in its infancy; it is, however, an infant of sturdy growth, likely to do good work in the world, and to be a credit to him who is its acknowledged father, as well as to those who have so carefully tended it in its early years.

But recent investigation in another direction bids fair even to eclipse the results which have been obtained by the examination of thermal phenomena. And this lies in the region of electrical chemistry. Faraday's work relating to conductivity of chemical substances has been already referred to, and this has been since substantiated and extended to pure substances by Kohlrausch. It has been shown, for example, that the resistance of absolutely pure water is almost an infinite quantity. But a small quantity of an acid, such as acetic or butyric acid, greatly increases the conductivity; but more than this, it is possible by determination of the conductivity of a mixture of water with these two acids to arrive at a conclusion as to the partition of the molecules of the water between the acids. Such a partition, however, implies a change of position, and therefore we are furnished with a means of recognising the motion of the molecules in a liquid, and of determining its amount. Thus it has been found that the hindrance to molecular motion is more affected by the chemical character of the liquid than by physical characters such as viscosity. We have seen that chemical change is always accompanied by molecular motion, and further evidence of the truth of this is gained from the extraordinary chemical inactivity of pure unmixed substances. Thus pure anhydrous hydrochloric acid does not act upon lime, whereas the addition of even a trace of moisture sets up a most active chemical change, and hundreds of other examples of a similar kind might be stated. Bearing in mind that these pure anhydrous compounds do not conduct, we are led to the conclusion that an intimate relation exists between chemical activity and conductivity. And we need not stop here; for a method is indicated indeed by which it will be possible to arrive at a measure of chemical affinity from determination of conductivity. It has indeed been already shown that the rate of change in the saponification of acetic ether is directly proportional to the conductivity of the liquid employed.

Such wide-reaching inquiries into new and and fertile fields, in which we seem to come into nearer touch with the molecular state of matter, and within a measurable distance of accurate mathematical expression, leads to confident hope that Lord Rayleigh's pregnant words at Montreal may ere long be realised: "It is from the further study of electrolysis that we may expect to gain improved views as to the nature of chemical reactions, and of the forces concerned in bringing them about; and I cannot help thinking that the next great advance, of which we already have some foreshadowing, will come on this side."

There is, perhaps, no branch of our science in which the doctrine of the Daltonian atom plays a more conspicuous part than in organic chemistry or the chemistry of the carbon compounds, as there is certainly none in which such wonderful progress has been made during the last fifty years. One of the most striking and perplexing discoveries made rather more than half a century ago was that chemical compounds could exist which, whilst possessing an identical chemical composition,—that is, containing the same percentage quantity of their constituents,—are essentially distinct chemical substances exhibiting different properties. Dalton was the first to point out the existence of such substances, and to suggest that the difference was to be ascribed to a different or to a multiple arrangement of the constituent atoms. Faraday soon afterwards proved that this supposition was correct, and the research of Liebig and Wöhler on the identity of composition of the salts of fulminic and cyanic acid gave further confirmation to the conclusion, leading Faraday to remark that "now we are taught to look for bodies composed of the same elements in the same proportion but differing in their qualities, they may probably multiply upon us." How true this prophecy has become we may gather from the fact that we now know of thousands of cases of this kind, and that we are able not only to explain the reason of their difference by virtue of the varying position of the atoms within the molecule, but even to predict the number of distinct variations in which any given chemical compound can possibly exist. How large this number may become may be understood from the fact that, for example, one chemical compound, a hydrocarbon containing thirteen atoms of carbon combined with twenty-eight atoms of hydrogen, can be shown to be capable of existing in no less than 802 distinct forms.

Experiment in every case in which it has been applied has proved the truth of such a prediction, so that the chemist has no need to apply the cogent arguments sometimes said to be used by experimentalists enamoured of pet theories, "When facts do not agree with theory, so much the worse for the facts!" This power of successful prediction constitutes a high-water mark in science, for it indicates that the theory upon which such a power is based is a true one.

But if the Daltonian atom forms the foundation of this theory, it is upon a knowledge of the mode of arrangement of these atoms and on a recognition of their distinctive properties that the superstructure of modern organic chemistry rests. Certainly it does appear almost to verge on the miraculous that chemists should now be able to ascertain with certainty the relative position of atoms in a molecule so minute that millions upon millions, like the angels in the schoolmen's discussion, can stand on a needle's point. And yet this process of orientation is one which is accomplished every day in our laboratories, and one which more than any other has led to results of a startling character. Still, this sword to open the oyster of science would have been wanting to us if we had not taken a step farther than Dalton did, in the recognition of the distinctive nature of the elemental atoms. We now assume on good grounds that the atom of each element possesses distinct capabilities of combination; some a single capability, others a double, others a triple, and others again a fourfold combining capacity. The germs of this theory of valency, one of the most fruitful of modern chemical ideas, were enunciated by Frankland in 1852, but the definite explanation of the linking of atoms, of the tetrad nature of the carbon atoms, their power of combination, and of the difference in structure between the fatty and aromatic series of compounds, was first pointed out by Kekulé in 1857; though we must not forget that this great principle was foreshadowed so long ago as 1833 from a physical point of view by Faraday in his well-known laws of electrolysis, and that it is to Helmholtz in his celebrated Faraday lecture that we owe the complete elucidation of the subject; for, whilst Faraday has shown that the number of the atoms electrolytically deposited is in the inverse ratio of their valencies, Helmholtz has explained this by the fact that the quantity of electricity with which each atom is associated is directly proportional to its valency.

Amongst the tetrad class of elements, carbon, the distinctive element of organic compounds, finds its place; and the remarkable fact that the number of carbon compounds far exceeds that of all the other elements put together receives its explanation. For these carbon atoms not only possess four means of grasping other atoms, but these four-handed carbon atoms have a strong partiality for each other's company, and readily attach themselves hand in hand to form open chains or closed

rings to which the atoms of other elements join to grasp the unoccupied carbon hand, and thus to yield a dancing company in which all hands are locked together. Such a group, each individual occupying a given position with reference to the others, constitutes the organic molecule. When, in such a company, the individual members change hands, a new combination is formed. And as in such an assembly the eye can follow the changing positions of the individual members, so the chemist can recognise in his molecule the position of the several atoms, and explain by this the fact that each arrangement constitutes a new chemical compound possessing different properties, and account in this way for the decompositions which each differently constituted molecule is found to undergo.

Chemists are, however, not content with representing the arrangement of the atoms in one plane, as on a sheet of paper, but attempt to express the position of the atoms in space. In this way it is possible to explain certain observed differences in isomeric bodies which otherwise baffled our efforts. To Van t'Hoff, in the first instance, and more recently to Wislicenus, chemistry is indebted for work in this direction, which throws light on hitherto obscure phenomena, and points the way to still further and more important advances.

It is this knowledge of the mode in which the atoms in the molecule are arranged, this power of determining the nature of this arrangement, which has given to organic chemistry the impetus which has overcome so many experimental obstacles, and given rise to such unlooked-for results. Organic chemistry has now become synthetic. In 1837 we were able to build up but very few and very simple organic compounds from their elements; indeed the views of chemists were much divided as to the possibility of such a thing. Both Gmelin and Berzelius argued that organic compounds, unlike inorganic bodies, cannot be built up from their elements. Organic compounds were generally believed to be special products of the so-called vital force, and it was only intuitive minds, like those of Liebig and Wöhler, who foresaw what was coming, and wrote in 1837 strongly against this view, asserting that the artificial production in our laboratories of all organic substances, so far as they do not constitute a living organism, is not only probable but certain. Indeed they went a step further, and predicted that sugar, morphia, salicine, will all thus be prepared,—a prophecy which, I need scarcely remind you, has been after fifty years fulfilled, for at the present time we can prepare an artificial sweetening principle, an artificial alkaloid, and salicine.

In spite of these predictions, and in spite of Wöhler's memorable discovery in 1828 of the artificial production of urea, which did in reality break down for ever the barrier of essential chemical difference between the products of the inanimate and of the animate world, still, even up to a much later date, contrary opinions were held, and the synthesis of urea was looked upon as the exception which proves the rule. So it came to pass that for many years the artificial production of any of the more complicated organic substances was believed to be impossible. Now the belief in a special vital force has disappeared like the *ignis-fatuus*, and no longer lures us in the wrong direction. We know now that the same laws regulate the formation of chemical compounds in both animate and inanimate nature, and the chemist only asks for a knowledge of the constitution of any definite chemical compound found in the organic world in order to be able to promise to prepare it artificially.

But the progress of synthetic organic chemistry, which has of late been so rapid, was made in the early days of the half-century only by feeble steps and slow. Seventeen long years elapsed between Wöhler's discovery and the next real synthesis. This was accomplished by Kolbe, who in 1845 prepared acetic acid from its elements. But then a splendid harvest of results gathered in by chemists of all nations quickly followed, a harvest so rich and so varied that we are apt to be overpowered by its wealth, and amidst so much that is alluring and striking we may well find it difficult to choose the most appropriate examples for illustrating the power and the extent of modern chemical synthesis.

Next, as a contrast to our picture, let us for a moment glance back again to the state of things fifty years ago, and then notice the chief steps by which we have arrived at our present position. In 1837 organic chemistry possessed no scientific basis, and therefore no classification of a character worthy of the name. Writing to Berzelius in that year, Wöhler describes the condition of organic chemistry as one enough to drive a man mad. "It seems to me," says he "like the tropical forest primæval, full of the strangest growths, an endless and pathless thicket in which a man may well dread to wander." Still clearances had already been made in this wilderness of facts. Berzelius in 1832 welcomed the results of Liebig and Wöhler's research on benzoic acid as the dawn of a new era; and such it really was, inasmuch as it introduced a novel and fruitful idea, namely, the possibility of a group of atoms acting like an element by pointing out the existence of organic radicals. This theory was strengthened and confirmed by Bunsen's classical researches on the cacodyl compounds, in which he showed that a common group of elements which acts exactly as a metal can exist in the free state, and this was followed soon afterwards by isolation of the so-called alcohol radicals by Frankland and Kolbe. It is, however, to Schorlemmer that we owe our knowledge of the true constitution of these bodies, a matter which proved to be of vital importance for the further development of the science.

Turning our glance in another direction we find that Dumas, in 1834, by his law of substitution threw light upon a whole series of singular and unexplained phenomena, by showing that an exchange can take place between the constituent atoms in a molecule. Laurent indeed went farther, and assumed that a chlorine atom, for example, took up the position vacated by an atom of hydrogen and played the part of its displaced rival, so that the chemical and physical properties of the substitution-product were thought to remain substantially the same as those of the original body. A singular story is connected with this discovery. At a *soirée* in the Tuileries in the time of Charles X. the guests were almost suffocated by acrid vapours which were evidently emitted by the burning wax candles, and the great chemist Dumas was called in to examine into the cause of the annoyance. He found that the wax of which the candles were made had been bleached by chlorine, that a replacement of some of the hydrogen atoms of the wax by chlorine had occurred, and that the suffocating vapours consisted of hydrochloric acid given off during the combustion. The wax was as white and as odourless as before, and the fact of the substitution of chlorine for hydrogen could only be recognised when the candles were destroyed by burning. This incident induced Dumas to investigate more closely this class of phenomena, and the results of this investigation are embodied in his law of substitution. So far indeed did the interest of the French school of chemists lead them that some assumed that not only the hydrogen but also the carbon of organic bodies could be replaced by substitution. Against this idea Liebig protested, and in a satirical vein he informs the chemical public—writing from Paris under the *nom de plume* of S. Windler—that he has succeeded in substituting not only the hydrogen but the oxygen and carbon in cotton cloth by chlorine, and he adds that the London shops are now selling nightcaps and other articles of apparel made entirely of chlorine, goods which meet with much favour, especially for hospital use!

But the debt which chemistry, both inorganic and organic, thus owes, to Dumas' law of substitution is serious enough, for it proved to be the germ of Williamson's classical researches on etherification, as well as of those of Wurtz and Hofmann on the compound ammonias, investigations which lie at the base of the structure of

modern chemistry. Its influence has been, however, still more far-reaching, inasmuch as upon it depends in great measure the astounding progress made in the wide field of organic synthesis.

It may here be permitted to me to sketch in rough outline the principles upon which all organic syntheses have been effected. We have already seen that as soon as the chemical structure of a body has been ascertained its artificial preparation may be certainly anticipated, so that the first step to be taken is the study of the structure of the naturally occurring substance which it is desired to prepare artificially by resolving it into simpler constituents, the constitution oi which is already known. In this way, for example, Hofmann discovered that the alkaloid coneine —the poisonous principle of hemlock—may be decomposed into a simpler substance well known to chemists under rhe name of pyridine. This fact having been established by Hofmann, and the grouping of the atoms approximately determined, it was then necessary to reverse the process, and, starting with pyridine, to build up a compound of the required constitution and properties, a result recently achieved by Ladenberg in a series of brilliant researches. The well-known synthesis of the colouring-matter of madder by Graebe and Liebermann, preceded by the important researches of Schunck, and that of indigo by Baeyer, are other striking examples in which this method has been successfully followed.

Not only has this intimate acquaintance with the changes which occur within the molecules of organic compounds been utilised, as we have seen, in the synthesis of naturally occurring substances, but it has also led to the discovery of many new ones. Of these, perhaps the most remarkable instance is the production of an artificial sweetening agent termed saccharin, 250 times sweeter than sugar, prepared by a complicated series of reactions from coal-tar. Nor must we imagine that these discoveries are of scientific interest only, for they have given rise to the industry of the coal-tar colours, the value of which is measured by millions sterling annually, an industry which Englishmen may be proud to remember was founded by our countryman Perkin.

Another interesting application of synthetic chemistry to the needs of everyday life is the discovery of a series of valuable febrifuges, amongst which I may mention antipyrin as the most useful. An important aspect in connection with the study of these bodies is the physiological value which has been found to attach to the introduction of certain organic radicals, so that an indication is given of the possibility of preparing a compound which will possess certain desired physiological properties, or even to foretell the kind of action which such bodies may exert on the animal economy.

But it is not only the physiological properties of chemical compounds which stand in intimate relation with their constitution, for we find that this is the case with all their physical properties. It is true that at the beginning of our period any such relation was almost unsuspected, whilst at the present time the number of instances in which this connection has been ascertained is almost infinite. Amongst these perhaps the most striking is the relationship which has been pointed out between the optical properties and chemical composition. This was in the first place recognised by Pasteur in his classical researches on racemic and tartaric acids in 1848; but the first to indicate a quantitative relationship and a connection between chemical structure and optical properties was Gladstone in 1863. Great instrumental precision has been brought to bear on this question, and consequently most important practical applications have resulted. I need only refer to the well-known accurate methods now in everyday use for the determination of sugar by the polariscope, equally valuable to the physician and to the manufacturer.

But now the question may well be put, Is any limit set to this synthetic power of the chemist? Although the danger of dogmatising as to the progress of science has already been shown in too many instances, yet one cannot help feeling that the barrier which exists between the organised and unorganised worlds is one which the chemist at present sees no chance of breaking down.

It is true that there are those who profess to foresee that the day will arrive when the chemist, by a succession of constructive efforts, may pass beyond albumen, and gather the elements of lifeless matter into a living structure. Whatever may be said regarding this from other standpoints, the chemist can only say that at present no such problem lies within his province. Protoplasm, with which the simplest manifestations of life are associated, is not a compound, but a structure built up of compounds. The chemist may successfully synthesise any of its component molecules, but he has no more reason to look forward to the synthetic production of the structure than to imagine that the synthesis of gallic acid leads to the artificial production of gall-nuts.

Although there is thus no prospect of our effecting a synthesis of organised material, yet the progress made in our knowledge of the chemistry of life during the last fifty years has been very great, and so much so indeed that the sciences of physiological and of pathological chemistry may be said to have entirely arisen within this period.

In the introductory portion of this address I have already referred to the relations supposed to exist fifty years ago between vital phenomena and those of the inorganic world. Let me now briefly trace a few of the more important steps which have marked the progress of this branch of science during this period. Certainly no portion of our science is of greater interest, nor, I may add, of greater complexity, than that which, bearing on the vital functions both of plants and of animals, endeavours to unravel the tangled skein of the chemistry of life, and to explain the principles according to which our bodies live, and move, and have their being. If, therefore, in the less complicated problems with which other portions of our science have to deal, we find ourselves, as we have seen, often far from possessing satisfactory solutions, we cannot be surprised to learn that with regard to the chemistry of the living body—whether vegetable or animal—in health or disease we are still farther from a complete knowledge of phenomena, even those of fundamental importance.

It is of interest here to recall the fact that nearly fifty years ago Liebig presented to the Chemical Section of this Association a communication in which, for the first time, an attempt was made to explain the phenomena of life on chemical and physical lines, for in this paper he admits the applicability of the great principle of the conservation of energy to the functions of animals, pointing out that the animal cannot generate more heat than is produced by the combustion of the carbon and hydrogen of his food.

"The source of animal heat," says Liebig, "has previously been ascribed to nervous action or to the contraction of the muscles, or even to the mechanical motions of the body, as if these motions could exist without an expenditure of force [equal to that] consumed in producing them." Again he compares the living body to a laboratory furnace in which a complicated series of changes occur in the fuel, but in which the end-products are carbonic acid and water, the amount of heat evolved being dependent, not upon the intermediate, but upon the final products. Liebig asked himself the question, does every kind of food go to the production of heat; or can we distinguish, on the one hand, between the kind of food which goes to create warmth, and, on the other, that by the oxidation of which the motions and mechanical energy of the body are kept up? He thought that he was able to do this, and he divided food into two categories; the starchy or carbohydrate food is that, said he, which by its combustion provides the warmth necessary for the existence and life of the body. The albuminous or nitrogenous constituents of our food, the flesh meat, the

gluten, the casein out of which our muscles are built up, are not available for the purposes of creating warmth, but it is by the waste of those muscles that the mechanical energy, the activity, the motions of the animal are supplied. "We see," said Liebig, "that the Esquimaux feeds on fat and tallow, and this burning in his body keeps out the cold. The Gaucho, riding on the pampas, lives entirely on dried meat, and the rowing man and pugilist, trained on beefsteaks and porter, require little food to keep up the temperature of their bodies, but much to enable them to meet the demand for fresh muscular tissue, and for this purpose they need to live on a strongly nitrogenous diet."

Thus far Liebig. Now let us turn to the present state of our knowledge. The question of the source of muscular power is one of the greatest interest, for, as Frankland observes, it is the corner-stone of the physiological edifice and the key to the nutrition of animals.

Let us examine by the light of modern science the truth of Liebig's view—even now not uncommonly held—as to the functions of the two kinds of food, and as to the cause of muscular exercise being the oxidation of the muscular tissue. Soon after the promulgation of these views, J. R. Mayer, whose name as the first expositor of the idea of the conservation of energy is so well known, warmly attacked them, throwing out the hypothesis that all muscular action is due to the combustion of food, and not to the destruction of muscle, proving his case by showing that if the muscles of the heart be destroyed in doing mechanical work the heart would be burnt up in eight days! What does modern research say to this question? Can it be brought to the crucial test of experiment? It can; but how? Well, in the first place we can ascertain the work done by a man or any other animal; we can measure this work in terms of our mechanical standard, in kilogramme-metres or foot-pounds. We can next determine what is the destruction of nitrogenous tissue at rest and under exercise by the amount of nitrogenous material thrown off by the body. And here we must remember that these tissues are never completely burnt, so that free nitrogen is never eliminated. If now we know the heat-value of the burnt muscle, it is easy to convert this into its mechanical equivalent, and thus measure the energy generated. What is the result? Is the weight of muscle destroyed by ascending the Faulhorn or by working on the treadmill sufficient to produce on combustion heat enough when transformed into mechanical exercise to lift the body up to the summit of the Faulhorn or to do the work on the treadmill? Careful experiment has shown that this is so far from being the case that the actual energy developed is twice as great as that which could possibly be produced by the oxidation of the nitrogenous constituents eliminated from the body during twenty-four hours. That is to say, taking the amount of nitrogenous substance cast off from the body, not only whilst the work was being done but during twenty-four hours, the mechanical effect capable of being produced by the muscular tissue from which this cast-off material is derived would only raise the body halfway up the Faulhorn, or enable the prisoner to work half his time on the treadmill

Hence it is clear that Liebig's proposition is not true. The nitrogenous constituents of the food do doubtless go to repair the waste of muscle, which, like every other portion of the body, needs renewal, whilst the function of the non-nitrogenous food is not only to supply the animal heat, but also to furnish, by its oxidation, the muscular energy of the body.

We thus come to the conclusion that it is the potential energy of the food which furnishes the actual energy of the body, expressed in terms either of heat or of mechanical work.

But there is one other factor which comes into play in this question of mechanical energy, and must be taken into account; and this factor we are as yet unable to estimate in our usual terms. It concerns the action of the mind upon the body, and, although incapable of exact expression, exerts none the less an important influence on the physics and chemistry of the body, so that a connection undoubtedly exists between intellectual activity or mental work and bodily nutrition. In proof that there is a marked difference between voluntary and involuntary work, we need only compare the mechanical action of the heart, which never causes fatigue, with that of the voluntary muscles, which become fatigued by continued exertion. So, too, we know well that an amount of drill which is fatiguing to the recruit is not felt by the old soldier, who goes through the evolutions automatically. What is the expenditure of mechanical energy which accompanies mental effort, is a question which science is probably far removed from answering. But that the body experiences exhaustion as the result of mental activity is a well recognised fact. Indeed, whilst the second law of thermodynamics teaches that in none of the mechanical contrivances for the conversion of heat into actual energy can such a conversion be complete, it is perhaps possible, as Helmholtz has suggested, that such a complete conversion may take place in the subtle mechanism of the animal organism.

The phenomena of vegetation, no less than those of the animal world, have, however, during the last fifty years been placed by the chemist on an entirely new basis. Although before the publication of Liebig's celebrated report on chemistry and its application to agriculture, presented to the British Association in 1840, much had been done, many fundamental facts had been established, still Liebig's report marks an era in the progress of this branch of our science. He not only gathered up in a masterly fashion the results of previous workers, but put forward his own original views with a boldness and frequently with a sagacity which gave a vast stimulus and interest to the questions at issue. As a proof of this I may remind you of the attack which he made on, and the complete victory which he gained over, the humus theory. Although Saussure and others had already done much to destroy the basis of this theory, yet the fact remained that vegetable physiologists up to 1840 continued to hold to the opinion that humus, or decayed vegetable matter, was the only source of the carbon of vegetation. Liebig, giving due consideration to the labours of Saussure, came to the conclusion that it was absolutely impossible that the carbon deposited as vegetable tissue over a given area, as for instance over an area of forest land, could be derived from humus, which is itself the result of the decay of vegetable matter. He asserted that the whole of the carbon of vegetation is obtained from the atmospheric carbonic acid, which, though only present in the small relative proportion of four parts in 10,000 of air, is contained in such absolutely large quantity that if all the vegetation on the earth's surface were burnt, the proportion of carbonic acid which would thus be thrown into the air would not be sufficient to double the present amount.

That this conclusion of Liebig's is correct needed experimental proof, but such proof could only be given by long-continued and laborious experiment, and this serves to show that chemical research is not now confined to laboratory experiments lasting perhaps a few minutes, but that it has invaded the domain of agriculture as well as of physiology, and reckons the periods of her observations in the field not by minutes, but by years. It is to our English agricultural chemists Lawes and Gilbert that we owe the complete experimental proof required. And it is true that this experiment was a long and tedious one, for it has taken forty-four years to give the definite reply. At Rothamsted a plot was set apart for the growth of wheat. For forty-four successive years that field has grown wheat without addition of any carbonised manure; so that the only possible source from which the plant could obtain the carbon for its growth is the atmospheric carbonic acid. Now, the quantity of carbon which on an average was removed in the form of wheat and straw from a plot

manured only with mineral matter was 1000 pounds, whilst on another plot, for which a nitrogenous manure was employed, 1500 pounds more carbon was annually removed, or 2500 pounds of carbon are removed by this crop annually without the addition of any carbonaceous manure. So that Liebig's prevision has received a complete experimental verification.

May I, without wearying you with experimental details, refer for a moment to Liebig's views as to the assimilation of nitrogen by plants—a much more complicated and difficult question than the one we have just considered—and compare these with the most modern results of agricultural chemistry? We find that in this case his views have not been substantiated. He imagined that the whole of the nitrogen required by the plant was derived from atmospheric ammonia; whereas Lawes and Gilbert have shown by experiments of a similar nature to those just described, and extending over a nearly equal length of time, that this source is wholly insufficient to account for the nitrogen removed in the crop, and have come to the conclusion that the nitrogen must have been obtained either from a store of nitrogenous material in the soil or by absorption of free nitrogen from the air. These two apparently contradictory alternatives may perhaps be reconciled by the recent observations of Warington and of Berthelot, which have thrown light upon the changes which the so-called nitrogenous capital of the soil undergoes, as well as upon its chemical nature, for the latter has shown that under certain conditions the soil has the power of absorbing the nitrogen of the air, forming compounds which can subsequently be assimilated by the plant.

Touching us as human beings even still more closely than the foregoing, is the influence which chemistry has exerted on the science of pathology, and in no direction has greater progress been made than in the study of micro-organisms in relation to health and disease. In the complicated chemical changes to which we give the names of fermentation and putrefaction, the views of Liebig, according to which these phenomena are of a purely chemical character, have given way under the searching investigations of Pasteur, who established the fundamental principle that these processes are inseparably connected with the life of certain low forms of organisms. Thus was founded the science of bacteriology which in Lister's hands has yielded such splendid results in the treatment of surgical cases; and in those of Klebs, Koch, and others, has been the means of detecting the cause of many diseases both in man and animals; the latest and not the least important of which is the remarkable series of successful researches by Pasteur into the nature and mode of cure of that most dreadful of maladies, hydrophobia. And here I may be allowed to refer with satisfaction to the results of the labours on this subject of a committee, the formation of which I had the honour of moving for in the House of Commons. These results confirm in every respect Pasteur's assertions, and prove beyond a doubt that the adoption of his method has prevented the occurrence of hydrophobia in a large proportion of persons bitten by rabid animals, who, if they had not been subjected to this treatment would have died of that disease. The value of his discovery is, however, greater than can be estimated by its present utility, for it shows that it may be possible to avert other diseases besides hydrophobia by the adoption of a somewhat similar method of investigation and of treatment. This, though the last, is certainly not the least of the debts which humanity owes to the great French experimentalist. Here it might seem as if we had outstepped the boundaries of chemistry, and have to do with phenomena purely vital. But recent research indicates that this is not the case, and points to the conclusion that the microscopist must again give way to the chemist, and that it is by chemical rather than by biological investigation that the causes of diseases will be discovered, and the power of removing them obtained. For we learn that the symptoms of infective diseases are no more due to the microbes which constitute the infection than alcoholic intoxication is produced by the yeast-cell, but that these symptoms are due to the presence of definite chemical compounds, the result of the life of these microscopic organisms. So it is to the action of these poisonous substances formed during the life of the organism, rather than to that of the organism itself, that the special characteristics of the disease are to be traced; for it has been shown that the disease can be communicated by such poisons in entire absence of living organisms.

If I have thus far dwelt on the progress made in certain branches of pure science it is not because I undervalue the other methods by which the advancement of science is accomplished, viz., that of the application and of the diffusion of a knowledge of nature, but rather because the British Association has always held, and wisely held, that original investigation lies at the root of all application, so that to foster its growth and encourage its development has for more than fifty years been our chief aim and wish.

Had time permitted I should have wished to have illustrated this dependence of industrial success upon original investigation, and to have pointed out the prodigious strides which chemical industry in this country has made during the fifty years of her Majesty's reign. As it is I must be content to remind you how much our modern life, both in its artistic and useful aspects, owes to chemistry, and, therefore, how essential a knowledge of the principles of the science is to all who have the industrial progress of the country at heart.

This leads me to refer to what has been accomplished in this country of ours towards the diffusion of scientific knowledge amongst the people during the Victorian era. It is true that the English people do not possess, as yet, that appreciation of the value of science so characteristic of some other nations. Up to very recent years our educational system, handed down to us from the middle ages, has systematically ignored science, and we are only just beginning, thanks in a great degree to the prevision of the late Prince Consort, to give it a place, and that but an unimportant one, in our primary and secondary schools or in our universities. The country is, however, now awakening to the necessity of placing its house in order in this respect, and is beginning to see that if she is to maintain her commercial and industrial supremacy the education of her people from top to bottom must be carried out on new lines. The question as to how this can be most safely and surely accomplished is one of transcendent national importance, and the statesman who solves this educational problem will earn the gratitude of generations yet to come.

In conclusion, may I be allowed to welcome the unprecedentedly large number of foreign men of science who have on this occasion honoured the British Association by their presence, and to express the hope that this meeting may be the commencement of an international scientific organisation, the only means nowadays existing, to use the words of one of the most distinguished of our guests, of establishing that fraternity among nations from which politics appear to remove us further and further by absorbing human powers and human work, and directing them to purposes of destruction. It would indeed be well if Great Britain, which has hitherto taken the lead in so many things that are great and good, should now direct her attention to the furthering of international organisations of a scientific nature. A more appropriate occasion than the present meeting could perhaps hardly be found for the inauguration of such a movement.

But whether this hope be realised or not, we all unite in that one great object, the search after truth for its own sake, and we all, therefore, may join in re-echoing the words of Lessing: "The worth of man lies not in the truth which he possesses, or believes that he possesses, but in the honest endeavour which he puts forth to secure that truth; for not by the possession of truth, but by the search after it are the faculties of man enlarged, and in

this alone consists his ever-growing perfection. Possession fosters content, indolence, and pride. If God should hold in His right hand all truth, and in His left hand the ever-active desire to seek truth, though with the condition of perpetual error, I would humbly ask for the contents of the left hand, saying, 'Father, give me this; pure truth is only for thee.'"

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT.

Fellow of the American Association for the Advancement of Science; Member of the Academy of Natural Sciences, Philadelphia; of the Berliner Chemische Gesellschaft, &c., &c.

(Continued from p. 89).

Extract (1).

My attention was not directed to the presence of saponin in *extract*(1), for the characteristic properties which it imparted to *extracts* (2), (3), and (4), were absent; but, it was evident that saponin was present in the bark, for on boiling the latter in distilled water, the presence of the compound was indicated. The solution frothed on shaking, and by adding a concentrated solution of caustic baryta, saponin-baryta was precipitated.†

A colouring matter‡ contained in the bark was extracted, and imparted to the *alcoholic extract* a brilliant red colour. It was precipitated by sub-acetate of lead, and the lead precipitate suspended in water and decomposed by sulphuretted hydrogen. The lead sulphide filtrate was evaporated over a water-bath until the odour of sulphuretted hydrogen was expelled, and the concentrated liquid was placed over sulphuric acid to evaporate slowly. A crystalline residue was obtained. On addition of alkalies to the colourless lead sulphide filtrate the red colour of the original solution was developed. Acid discharged the colour. Acetic ether took up the red coloured substance. The acetic ether residue was a red uniform solid, and soluble in water. It was precipitated from the aqueous solution by sub-acetate of lead, potassium bichromate, ferric chloride, ferrous sulphate, and it was clouded by alum, and stannous chloride solutions.

Tannin, gallic acid, and alkaloids were absent.

Amyl alcohol separated from the acidified aqueous extract white needle-shaped crystals. It was not determined if these crystals were the same as those of the colouring matter.

Extracts (2), (3), *and* (4).

Extracts (2) and (3) when warm were clear, and on cooling a creamy-white solid separated. Extract (4), if warmed, was turbid, and as the liquid cooled, a creamy-white substance remained at the bottom of the flask, and the supernatant fluid became clear. This creamy-white substance was identified in each of the *extracts* as saponin§.

The results following an aqueous treatment of *alcoholic residues* (2) and (3) were noticeable. The *residues* were dissolved, and by shaking the mixtures, emulsified. This emulsion was permanent, as no resinous matter separated on standing several days. The emulsion was agitated with acetic ether, and by this means most of the resin and saponin were separated from the aqueous portion. The saponin was removed mechanically with the resin, as it is almost insoluble in acetic ether. The resin-saponin mass was insoluble in ether, soluble in water. The solution frothed on shaking and emulsified, but the emulsion was not so permanent as in the first case, for a resinous sediment settled after a time. Chloroform separated saponin from an acidified aqueous solution, and also from an alkaline aqueous solution of the *residues*; and the red-violet saponin reaction with concentrated sulphuric acid was obtained.

The solubility in water of the *alcoholic residues* (2), (3)' and (4), and the resulting emulsion were unusual, and explicable by the facts collected from a series of experiments with resins and saponin, since I had successfully emulsified resins with aqueous and alcoholic saponin solutions.*

By hot alcoholic treatment the *yucca* yielded a residue of saponin and resin which became emulsified on the addition of water, giving results identical with those of the resins above described.†

Extract (4) contained a resin. It was an opaque reddish yellow coloured substance, and it differed, by its reactions, from the many resin classes given in Hirschsohn's scheme. It is propose to name it pyrophæal.‡ A resin having the same melting point, solubilities, physical appearance, and chemical reactions, was discovered in the *ethereal extract* (4). It was identified as the same compound for which the name pyrophæal is proposed.

Tannin, gallic acid, and alkaloids were not detected in *extracts* (2), (3), and (4). In *extract* (3) glucose was not found.

Summary III.—*Alcoholic Extracts.*

	Solids extracted.	Character of residue.	Reaction with litmus.	Quantitative estimation of glucose.	Quantitative estimation of saccharose or other reducible compounds
1. The bark of the root ..	9·25 p.c.	0·20 p.c. ash	Red colouring matter crystalline.	Neutral.	0·619 p.c.	0·180 p.c.
2. „ wood „	14·30 „	0·10 „	Resin, saponin.	„	1·592 „	0·929 „
3. „ green leaf	3·80 „	0·15 „	Resins, „	„	none	none
4. „ yellow base of leaf..	4·30 „	0·05 „	Resin, „	Slightly acid.	traces	traces

The Solids of the Alcoholic Extracts.

I. A red colouring matter (crystalline).
II. A new resin (yuccal).§
III. A second new resin (pyrophæal).§
IV. A mixture of a crystalline resin and a resin anhydride.
V. Saponin.§
VI. Glucose, and saccharose or other reducible compounds.
VII. Ash.

(To be continued).

* Reprinted from the *Transactions of the American Philosophical Society*.

† Saponin in the bark of *Yucca angustifolia*. *Science*, September 11, 1885.

‡ A red crystalline colouring matter. *Science*, September 11, 1885.

§ Saponin in the wood of the root and leaves. *Science*, September 11, 1885.

* The same kinds of resins were used in these experiments as in those with which I determined the solubility of resins in acetic ether. See foot-note (2), *ethereal extract* (2).

† It was not until a later date following the time of these experiments that I found a reference to saponin-resin emulsion in L'Officine ou Répertoire General de Pharmacie Pratique, par Dorvault. Huitième Edition, Paris, 1872, p. 816. Also, refer to examination of the *Yucca angustifolia*, by H. C. De S. Abbott, published in the *Medical and Surgical Reporter*, Philadelphia, September 12, 1885, p. 301.

‡ Pyrophæal, *loc. cit.*

§ *Science*, September 11, 1885, p. 210. Abstract of a paper on the chemical study of *Yucca angustifolia* by H. C. De S. Abbott.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING JULY 31ST, 1887.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To THE WATER EXAMINER, *Metropolis Water Act*, 1871.

London, August 5th, 1887.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from July 1st to July 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The water supply of the past month was characterised by an appreciable diminution in the habitually small proportion of organic matter present. In the case of the companies taking their supply from the Thames, the mean amount of organic carbon was 0·146 part, and the maximum in any one sample 0·169 part in 100,000 parts of the water, corresponding respectively to about one quarter of a grain, and to about three-tenths of a grain of organic matter per gallon. More marked even than the diminution of its proportion of organic matter was the increased degree of freedom of the water from other than a bluish tint of colour. The slight turbidity manifest occasionally for some months past in the East London Company's water, was noticeable during the past month, and that to a very insignificant extent, in two samples only.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

NOTICES OF BOOKS.

Studies from the Laboratory of Physiological Chemistry of Yale University. For the year 1885-86. Vol. II. Edited by R. H. CHITTENDEN, Ph.D., Professor of Physiological Chemistry. Newhaven: Tuttle, Morehouse, and Taylor.

DR. CHITTENDEN here records the results of a series of important investigations in physiological chemistry. He has examined the alleged dehydration of glucose in the stomach and intestines, but finds himself unable to confirm the view of Dr. F. W. Pavy, that glucose is not the final product of amylolytic action, but is capable of transformation within the animal system into a compound which has less power of reducing cupric oxide. It is incidentally mentioned that M. Ogata, who experimented on dogs, was unable to confirm Dr. Pavy's results.

In concert with M. T. Hutchinson the author has studied the influence of uranium salts on the amylolytic action of saliva, and the proteolytic action of pepsine and trypsine. This paper is only the beginning of an inquiry into the physiological and toxic action of uranium salts.—a subject as yet very imperfectly investigated. The authors acknowledge in the outset the kindness of Prof. H. Carrington Bolton in supplying them with a sufficiency of pure compounds of uranium. The various uranium salts tried were found to have a decidedly inhibitory action on the transformation of starch under the action of saliva.

The manner in which the uranium salts diminish the amylolytic action of the ferment has not been directly ascertained. The authors consider the loss of power due in part to a partial direct destruction of the ferment, as well as to a change in the reaction of the fluid.

Proteolytic action is also retarded by the uranium salts.

The next subject studied is the relative distribution of antimony in the organs and tissues of the body under various conditions. This is a question of no small practical importance, since the relative proportion of poison found in the different tissues after death may prove of chemico-legal importance.

The first point to be ascertained was the determination of antimony existing in admixture with large quantities of organic matter, solid or liquid. The electrolytic method was found to give satisfactory results.

As regards the distribution of the poison in the system the authors not unnaturally expected that, as in the case of arsenic, soluble and easily diffusible forms of the poison would be absorbed by the brain in appreciable quantities. With antimony the results tend in the same direction, but are not so decisive as it might be wished.

Prof. Chittenden, assisted by J. A. Blake, has also studied the influence of antimonious oxide on metabolism. Small repeated doses of this compound are without influence on the elimination of nitrogen, sulphur, and phosphorus, and it has hence in non-poisonous doses no influence on proteid metabolism. Grohe and Mossler, however, have shown that antimony, regularly taken, induces fatty degeneration of the liver, kidneys, and heart. This fact has long been utilised in the production of the *foies gras* so beloved of gourmets. That morbid tissues, animal or vegetable, are unfit for human food can scarcely be seriously questioned.

It will be seen that the researches described in the last two papers could not have been undertaken in England without the arbitrary and capricious permission of the Home Secretary. To administer antimony to dogs or rabbits in order to ascertain its ultimate distribution and its influence, would be vivisection, and would consequently be deemed a "horrible sin." But to give it to geese for the promotion of gastronomy is, we presume, a meritorious act.

The remaining memoirs relate to globuline and globulose bodies, the peptones, some metallic compounds of albumen and myosin, egg-albumen and albumoses, casein and its primary splitting products, and the influence of some organic and inorganic substances on the metabolism of gases.

Exhibition of Petroleum Products.—During the autumn of the present year there will be held at St. Petersburg an Exhibition of Petroleum Products and Lighting Appliances. The Ministry of Imperial Domains offer a prize of 2500 roubles for the best cheap and simple lamp to burn heavy naphtha oils, and one of 1000 roubles for a more expensive lamp to burn the same kind of oil. The Ministry of War offers 500 roubles for a stove to heat rooms, burning naphtha waste; the same sum for a compact galvanic battery for actuating glow-lamps; a prize of 1000 roubles for an apparatus for night and day signalling, and one of 500 roubles for phosphorescent materials. The latest term for receiving exhibits is November 27. All articles must be addressed to the Exhibition Executive Commission of the Imperial Technical Society, St. Petersburg, Panteleimonovskaja, No. 2.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xxvi., Part 1.

The Carbolic Acids of Commerce.—C. Castelhaz.—From the *Bulletin de la Soc. Chimique de Paris.*

Specific Gravity of Solid, Melted, and Dissolved Paraffin.—G. Beilby.—From the *Journal of the Chemical Society.*

Detection of Free Sulphuric Acid in Aluminium Sulphate.—Hager.—The author heats 2 drops of gurjum balsam in a test-tube with 3 c.c. acetic acid, shaking up frequently. He adds about 0·25 of the pulverised aluminium sulphate, and heats with agitation again if the mixture has become cold. If traces of free sulphuric acid are present a light blue colour appears in about ten minutes. In the absence of free sulphuric acid the mixture appears yellowish or whitish yellow, and does not turn blue even in the course of many hours.

Apparatus for the Speedy Examination of Hydrogen Peroxide.—M. Martinon.—From the *Bulletin de la Soc. Chimique.*

Rapid Determination of Carbon in Cast-Metal, Steel, and Wrought Iron.—M. Zaboudsky.—From the *Bulletin de la Société Chimique.*

Analysis of Soils.—Antony Guyard.—From the *Bulletin de la Société Chimique.*

R. Palm's Process for obtaining Digitaline, Digitaleine, and Digitine.—According to A. Peltz and C. Leuken this process yields no alkaloids.

Examination of Extractum Belladonnæ.—An account of the processes of H. Kunz, W. Dunstan, F. Ranson, and O. Schweissinger.

Determination of Mercury in Urine.—A. Wolff and J. Nega render the process of Ludwig and Fürbringer more sensitive by combining it with the previous destruction of the organic matters and precipitation with hydrogen sulphide as recommended by Schridde.

Volumetric Determination of Total Nitrogen in Urine.—Horbaczewski simplifies Ludwig's process by dispensing with the previous concentration of the urine.

New Process for Determining Urea in Urine with Bromine Water.—Pflüge finds that good results may be obtained with diluted bromine water if the urea is previously converted into ammonium carbonate by means of strong soda lye.

The Presence of Sugar in Normal Human Urine.—C. Schilder.—By means of phenylhydrazine traces of sugar can be detected in all urine.

A Novel Reaction of Creatinine.—M. Jaffé.—If a solution of creatinine is mixed with an aqueous solution of picric acid and a few drops of dilute soda lye, it turns at once of an intense red. The depth of the colour, which varies from orange red to dark blood red, increases considerably in the first minutes and remains then unchanged for hours, but if the alkali is in excess it goes back to a yellow, especially on exposure to light. Acidulation with acetic or hydrochloric acid effects this change in a few minutes. Sodium picrate is of a pure yellow colour, and cannot be mistaken for the red colouration of creatinine. No other constituent of urine gives the reaction in the manner described. Creatinine gives a pure yellow, which passes into a red only after standing for some hours in the cold. Glucose does not yield, in the cold, the well known blood-red colour depending on the reduction of picric acid, or only after prolonged standing. Acetone certainly gives in the cold a faint reddish yellow shade, which, however, cannot be confounded with the redder and more intense reaction.

Albumen in Normal Urine.—C. Posner confirms the results of earlier observers, showing the presence of minute traces of albumen in normal urine.

Estimation of Albumen in Urine by Means of Esbach's Albumenimeter.—J. E. Blomfield (*Lancet*) and P. Guttmann (*Berliner Klin. Wochenschrift*) find this method fully adequate for medical purposes.

The Precipitate caused by Picric Acid in Normal Urine.—M. Jaffé.—The precipitate is a double compound of creatinine picrate and potassium picrate.

Detection of Blood-Pigment in Urine.—C. Rosenthat.—The spectroscopic method, according to the author, is available only to a limited degree. He obtained better results by recognising the iron in the ash of the precipitate given by tannin.

Simple Spectroscopic Method for the Detection of Hæmatine.—E. Hering shows that it is in certain cases advantageous in the examination of coloured fluids to use not a spectroscope but a simple prism. It is sufficient to place the fluid in a sufficiently thick stratum before a narrow slit cut in black paper, and to examine it against the light with a prism whose refractive edge is about 60°. The absorption bands appear as narrow sharply defined lines in the short spectrum.

Determination of Hæmoglobine in Blood.—E. v. Fleischl.—A description of the author's hæmometer for a colorimetric determination of the colouring-matter of blood, with an exactitude sufficient for clinical purposes.

Distribution of Arsenic in the Human Body.—R. H. Chittenden.—The particulars are not given, the reader being referred to the original paper in the *American Chemical Journal.*

Detection of Blood-Spots in Presence of Iron-Rust.—E. Dannenberg.—Already noticed.

Atomic Weight of Uranium.—Clemens Zimmermann.—Already noticed under *Liebig's Annalen.*

MISCELLANEOUS.

British Association for the Advancement of Science.—Section B.—The following is a preliminary list of the Papers which will be brought forward in the Chemical Section :—

F. W. Clarke.—The Chemical Structure of Natural Silicates.

J. W. Mallet, F.R.S.—Preliminary Notice of a Redetermination of the Atomic Weight of Gold, with some Remarks on the Present State of our Knowledge as to the Determination of Atomic Weights in General.

Dr. G. H. Bailey.—The Atomic Weight of Zirconium.

Dr. G. H. Bailey.—The Absorption Spectra of the Rare Earths, with Special Reference to the Recent Announcement of New Elements.

Dr. G. H. Bailey and Professor Schuster, F.R.S.—The Absorption Spectra of the Salts of Didymium under Polarised Light.

W. Thomson.—On the Antiseptic Properties of some Fluorine Compounds.

Prof. Carnelley.—The Antiseptic Properties of Metallic Salts in relation to their Chemical Composition.

Dr. A. Richardson.—Action of Light on the Hydracids of the Halogens in presence of Oxygen.

Prof. Dunstan and T. S. Dymond.—Reduction Products of the Nitro-Paraffin and Alkyl Nitrites.

John A. Hall.—Organic Vanadates.

Dr. Noelting.—The Six Isomeric Azoxylols.

Dr. Noelting.—On Substitution in the Azo Compounds.

Dr. Noelting.—On Azo-imido Compounds.

Prof. Carnelley and Dr. A. Thomson.—The Solubility of Isomeric Organic Compounds.

Prof. Carnelley.—The Melting-points of Organic Compounds in relation to their Chemical Constitution.

Prof. A. Berntham.—Some New Facts connected with some of the Colouring Matters.

Dr. C. Fahlberg.—Saccharine.

Dr. O. N. Witt.—The Constitution and Relationship of the Eurhodine and Saffranine Classes of Colouring-Matters, and their Connection with other Groups of Organic Compounds.

Dr. F. H. Bowman.—On the Present Condition of our Knowledge of the Chemical Composition of Cotton-Wool.

Prof. W. H. Perkin and Dr. J. B. Cohen.—Some New Cinnamic Acids.

W. B. Hart.—Some Organo-Silicon Compounds.

Dr. Bott and Prof. Schwarz.—The Derivatives and Constitution of the Pyrocresols.

Dr. Bott.—A New and Rapid Method of Testing Beer and other Alcoholic Liquors.

W. Durham.—Solution.

Dr. C. R. Alder Wright, F.R.S., and C. Thompson.—Notes on some Peculiar Voltaic Combinations.

Prof. Smithells.—Suggested Amendment of Chemical Nomenclature.

Prof. Sterry Hunt,—Integral Weights in Chemistry.

Dr. Springer.—Torsion Balances.

F. W. Watkin, M.A.—Apparatus suitable for Lecture Purposes for determining the Volume of Gas evolved in various Chemical Actions, with or without the application of Heat.

J. W. Mallet, F.R.S.—On a Partial Separation of the Constituents of a Solution during Expansion by Rise of Temperature.

J. W. Langley.—On a Probable Manifestation of Chemical Attraction as a Mechanical Stress.

Prof. Lunge.—On the Composition of some Coke-Oven Tars of German Origin.

Prof. Lunge.—A New Apparatus for Condensing Gases by Contact with Liquids.

Watson Smith.—On the Constituents of the Light Oils of Blast-Furnace Coal Tar from the Gartsherrie Works.

A. E. Fletcher.—The Present Position of the Alkali Trade.

T. Fairley.—Vacuum Injector Pumps for use in Chemical Laboratories.

Prof. Carnelley.—A New Method for Determining Micro-Organisms in Air.

R. Warington.—Reduction of Nitrates by Micro-Organisms.

Charles O'Neill.—The Extent to which Calico Printing and the Tinctorial Arts have been affected by the Introduction of Modern Colours.

M. M. Pattison Muir, M.A.—The Teaching of Chemistry.

Dr. Gilbert, F.R.S.—The Origin of Nitrogen in Plants.

Prof. H. E. Armstrong.—Valency.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Test for Tall w.—Can any of your readers give me particulars respecting the new test for tallow which I believe is known as the "Tita" test, how used, and for what purposes employed?—H. N. Warren.

IRON TUBES AND FITTINGS for Gas, Water, Steam, Liquid Ammonia, and Hydraulic Work, galvanised white enamelled inside, or coated by Dr. Angus Smith's Composition. COILS for heating superheating, distilling, and refrigerating purposes, to 500 feet long without joints. Iron and brass cocks and valves.—JOHN SPENCER, Globe Tube Works, Wednesbury, and 14, Great St. Thomas Apostle, Cannon St., London, E.C.

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By Order, JOHN GRAVES,
Town Hall Salford, Town Clerk.
August 25th, 1887.

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SESSION 1887-88.

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The SESSION 1887-88 will commence on Saturday, October 1st, 1887. The New Buildings which were opened by T.R.H. The Prince and Princess of Wales, on May 21st, afford more than double the accommodation which was provided formerly.

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THE CHEMICAL NEWS.

Vol. LVI. No. 1450.

ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.*

By EDWARD SCHUNCK, Ph.D., F.R.S. F.C.S.,
President of the Section.

Ladies and Gentlemen,—It is, I can assure you, with a feeling of extreme diffidence that I take the chair to-day as President of the Chemical Section at this meeting of the British Association. When I look round me and see the many distinguished men who are prepared to take part in our proceedings I cannot but very strongly feel that the Council's choice might have fallen on a worthier representative of chemical science than myself. Having in the course of my career bestowed more time and attention to technical matters than to purely scientific subjects, and having moreover arrived at a time of life when active participation in work of any kind must necessarily be drawing to a close, you must not expect from me the accurate knowledge of the present state of chemical science and the questions that are at this moment presenting themselves for solution such as would naturally be required from anyone occupying the post which I have on this occasion the honour to hold. The marvellously rapid progress of chemistry during the last twenty years has made it difficult for the most industrious cultivator of the science to keep abreast of the knowledge of the day, and for a *dilettante* like myself one may say it is next to impossible. I confess myself painfully conscious of my defects in this respect, and I shall therefore have to claim the indulgence of the Section should questions arise on which I am unable to speak with authority, or even to discuss with advantage.

Considering, however, how efficiently I am supported by the gentlemen with whom I have the honour to be associated, and to whom I am sure in any case of difficulty I may appeal for assistance, I trust to be able to perform the duties of my office without discredit. I will not, however, trouble you with merely personal questions, which are always more or less tedious, but proceed with the few remarks which I wish to make, and which, if not new or instructive, may perhaps serve to entertain you during the time usually devoted to addresses of this kind.

I think you will hardly expect me, even were I fully competent to do so, to review the progress of chemistry during the last half-century, for the time at my disposal would be too short and the result at my hands, I fear, unsatisfactory. I shall prefer to call attention in a few words to the chemistry of other days as I knew it and the chemistry of the present time as known to us all, and to point out what I consider to be the chief characteristics of each. I shall then, with your permission, point out a few of the directions in which, in my opinion, the chemistry of the future will probably be developed, and in this undertaking I shall perhaps be more successful than in the other; for to discuss the history of science requires exact knowledge, but in speculating on its future the imagination comes into play, and to imagine is easier than to describe.

When I first entered on my studies, exactly fifty years ago, chemistry could hardly be called a science—it was rather a collection of isolated facts unconnected by any consistent theory covering the whole field. Most of the important elements were known, but of the exact proportions in which they combine together we were ignorant. The law of definite proportion had been generally accepted, but so imperfect were the data then at our disposal that we may say the law was rather taken for granted than proved. The atomic theory of Dalton as explaining this law had also been adopted by chemists; but it is not unlikely that this theory, then in its infancy, might by the vigorous onslaught of a man of Berthollet's acumen have been upset, and we should then have been left entirely without a guide through the bewildering labyrinth of facts. Of any connection between chemistry and physics there was in those days no question; of any but the most superficial notions regarding the effects of heat, light, and electricity on chemical substances we had no conception. The idea that chemistry could have any bearing on or connection with physiology or pathology would have been ridiculed as absurd. I cannot think of the then state of organic chemistry without feeling amused. The state of this branch of chemistry could hardly perhaps be called chaotic or rudimentary, for, after all, what had been done had been well done and neatly done, but the assemblage of facts of which it consisted was devoid of systematic arrangement; it resembled a cabinet of curiosities, the components of which stand in no recognisable relation to one another, or a miscellaneous collection of books placed in an orderly manner on shelves, but without any attempt at classification. As to the genesis of organic compounds, what would now be called absurd notions prevailed. I distinctly remember eminent chemists maintaining that no strictly speaking organic body, even of the simplest constitution, could possibly be formed without the intervention of the so-called vital force. The fact, then recently discovered by Wöhler, of the artificial formation of urea from inorganic substances, was considered as something almost miraculous,—*i.e.*, as a phenomenon the like of which would never again recur. Without, however, entering into further details, I think I may, without fear of contradiction, assert that the main distinction between the chemistry of fifty years ago and the chemistry of the present day consists in this, that, whereas formerly the science dealt chiefly with qualitative reactions, it now occupies itself principally with quantitative determinations. To have established the fact that every chemical phenomenon may be represented in figures, denoting either number, measure, or weight, such figures, when once accurately determined, remaining constant and unchanged through all time—this seems to me the crowning glory of modern chemistry. It is the firm establishment of this principle that has transformed the face of chemistry and has changed it from a mere descriptive into an exact science.

In justice to our predecessors it should, however, be remembered that this principle, though more fully developed in our own day, was not for the first time set up in quite recent times. The labours of Dalton, conducted on quantitative lines, were performed in this city of Manchester in the early part of this century. At the same time Berzelius was engaged in analysing the most important inorganic compounds and establishing the fact, not previously recognised, strange as it may now appear, that every well-defined substance has a definite chemical composition. But going still further back, we come to the alchemists. Now alchemy, if it has any logical basis at all, is founded on quantitative notions as regards matter. All metals, the alchemists said, consist of sulphur, salt, and mercury (these terms signifying not so much elements in the modern sense as qualities) in various proportions; hence their convertibility. Take copper, remove from it a certain proportion of its sulphurous constituent, and add more of the mercurial, and you have silver; repeat the process with silver, and gold results. At the time of which I speak, though much important analytical work had been done by Berzelius, Rose, and others in inorganic chemistry though the veteran Chevreul had led the way in placing organic chemistry on a quantitative basis, and the composition of the most important organic compounds—thanks to the labours of Liebig and

* Read Thursday, September 1, 1887.

his method of organic analysis—had been ascertained, still quantitative determinations were not considered of such paramount importance as at present. In fact, scientific thought did not run in that direction, but satisfied itself, for the most part, with the study of qualitative reactions. It was still possible to see memoirs by eminent chemists containing not a single quantitative determination. Strange as it may seem, two able chemists, Boettger and Schoenbein, were living until quite recently who worked and obtained valuable results without resorting to the balance, the instrument which of all others seems the most indispensable to the chemist of to-day. The balance was indeed universally employed in my younger days, but no other instrument, properly so called, was ever seen in the laboratory. The spectroscope was not yet invented, the polariscope had not come into use; volumetric analysis was still in its infancy. Even the thermometer was but seldom used. What a different picture does the laboratory of the present day present, with its instruments of precision and its various appliances for effecting quantitative determinations of all kinds!

Whether the universal prevalence of and exclusive attention to quantitative methods in chemistry has been an unmixed good may be doubted. Who has not run with a weary eye over the long array of figures, the never-ending tables of which some modern memoirs seem to consist, and not longed for some mere description—were it only regarding trivial matters—to relieve the monotony and fix the subject treated of on the memory? That quantitative determinations given in quite precise terms may occasionally be entirely futile may be seen on referring to the history of alchemy. One of the later alchemists professes to have converted 5400 parts by weight of copper into 6552 parts of silver by the action of 1 part of a metal-improving substance (philosopher's stone).* Here we see the quantitative method applied to a purely chimerical process, elaborated from the depths of the experimenter's inner consciousness, and of no value whatever. Much of what is at the present day carefully worked out and presented to the world in numerical form may, like this statement of the alchemist, pass away and be forgotten. This may possibly be the case with the numerous carefully made analyses of water which we now meet with, and which we would gladly exchange for a few decided qualitative tests of its hygienic properties. In the case of air and water it is not the minuteness of the noxious matter which causes doubts to arise, but the absence of any decided and undoubted chemical characteristics of the impurities present. It is probable that a refined sense of taste, uncorrupted by the luxurious indulgences which civilisation has introduced, would be able to detect differences in drinking water which might escape the attention of the most consummate analyst.

Whatever objections may, however, be entertained to the application of quantitative methods in natural science, to the exclusion of others, it is certain that important results have flowed from their adoption, insomuch that we seem to have arrived at the conclusion that the expression of quantitative results is the be-all and end-all of science; that all differences are merely quantitative; that there is no such thing as mere quality. The whole philosophy of our age is expressed in this one proposition: All differences within the sphere of our experience are quantitative. It is the basis of Darwinism, if I am not mistaken, and underlies many of our political and social theories. Of course it is a mere assumption if stated generally, for the phenomena that admit of purely quantitative expression are few in number compared with those that do not; but then it is surmised, and with some degree of probability, that the vast region outside the quantitative sphere will in time come to be included within it. The past history of science seems to render this likely in the future. The science of chemistry has so far, however, presented an insuperable barrier to the general adoption of this view, and will continue to do so as long as the so-called elements remain what we now admit them to be—indestructible, immutable, inconvertible. It is possible to denote all the known properties of gold and silver, their atomic weight, specific gravity, hardness, malleability, action towards heat, light, and electricity in precise numbers with reference in each case to a certain standard, and yet we cannot say that silver, minus a little of this plus a little of that, constitutes gold—the two elements are essentially and radically distinct. Unless we admit with the alchemists that by taking away a little of A and adding a little of B we can convert one metal into another, one element into another, the quantitative method must fall short of its complete development in chemistry. Numerous attempts have therefore been made to show the theoretical probability, even if it should not be possible to prove it experimentally, of the so-called elements being really compound bodies, or at least of their containing a basic matter common to all. My predecessor in this chair has endeavoured to show, in the brilliant address delivered to this Section on the occasion of its last meeting, that the barrier hitherto presented to us by the intractability of our present elements may be overcome, and has adduced experimental illustrations in favour of his views of the compound nature of the elements. Mr. Crookes has called to his aid the doctrine of evolution, which has proved so valuable an instrument in the hands of the biologist, maintaining that the elements, like the species of plants and animals, were gradually evolved by some process of condensation from a primordial matter called by him protyle, each step in the process being represented by a distinct element. This is doubtless taking very safe ground, for if the process of evolution was the same in the inorganic as it is supposed to have been in the organic world, the process can never be repeated, and we shall therefore never be in a position to illustrate it experimentally. I may, however, have misunderstood what Mr. Crookes meant to convey, and, if so, must apologise for the dulness of my apprehension. Granting, however, the possibility of our resolving our present elements, were it in theory only, into modifications of one basic material out of which they have been evolved, the question would still remain to be answered, What has caused this primordial matter to be split up into groups and forms having distinct and opposite qualities? and when this question is answered, if it can be answered even in a problematical way, then other questions would arise, until by degrees we should arrive at the confines of physical knowledge and find ourselves in the region of metaphysics, where scientific reasoning ceases and thinking for scientific purposes becomes unprofitable. Excursions into this region would indeed be very useful if on returning to physical regions we could every time bring back with us an instrument as potent and far-reaching as the atomic theory has proved to be, a theory which still remains the basis of all our reasoning in chemistry; but then the atomic theory has been quite an exceptional instance. Metaphysical speculation, such as the Naturphilosophie of the Germans has dealt in, has, generally speaking, been utterly barren in natural science.

I will not on the present occasion dwell on the vast addition made to the number of useful and beautiful substances by chemists during the last fifty years. Their number is legion, and their mere description fills volumes, whereas half a century ago a dictionary of moderate size would have sufficed for the purpose. Among these newly discovered substances none are more remarkable than the metals rubidium, cæsium, thallium, indium, gallium, the existence of which was revealed by the spectroscope, and which, indeed, would have probably remained unknown but for the labours of Bunsen and Kirchoff in perfecting and applying that instrument.

I must not, however, omit all reference to a department of chemistry which has been, one may almost say, created within the time to which I am referring—I mean that of synthesis. When I began to study chemistry we only

* Kopp, *Die Alchemie.*

heard of analysis; of synthesis, so far at least as regards organic bodies, we only dreamt as a remote and unattainable region. The only instance then known of the synthesis of an organic substance was that of urea by Wöhler. Synthesis was, indeed, supposed to be an essentially vital process effected under the influence of the vital force, and quite outside the sphere of the chemist. Since then what marvels have we not seen? Alizarin and purpurin, the colouring-matters of madder, have been prepared artificially by Graebe and Liebermann, indigo by Baeyer, not to mention bodies of simpler constitution obtained by comparatively less complicated processes. We are honoured to-day by the presence of Professor Ladenburg, who has succeeded in artificially preparing coniin, the alkaloid to which hemlock owes its poisonous properties,—the first natural alkaloid, indeed, which has been obtained artificially. Looking back at what has been achieved I think we may entertain the confident anticipation that all the most important organic bodies, acids, alkaloids, and neutral substances will, in course of time, be obtained in a similar manner, though of one thing we may be pretty sure, viz., that we shall never succeed in forming any really organised matter as distinct from organic. The term organic matter is in fact only employed for the sake of convenience, and as an expression handed down to us from former days, since so-called organic compounds are subject to the same laws with regard to composition as the bodies which we name mineral or inorganic, but organised matter such as we find constituting the vessels of plants and animals is a different thing. The protoplasm contained in the vegetable and animal cell is something very distinct from the same matter after the death of the organism, but the difference between living and dead matter is not of a chemical nature. In referring to chemical synthesis I cannot refrain from expressing regret that so little has hitherto been done in the artificial production of minerals with a view to elucidating the processes by which they were formed in nature, but it is possible that more has been done in this direction than I am aware of, since this is a department of chemistry with which I am not familiar. It is certain that inorganic chemistry generally does not now receive the attention which it formerly did. The exclusive devotion to the chemistry of the carbon compounds which we find in most of our laboratories at the present day may, however, be accounted for when we see the brilliant results to which the study of those compounds has led.

After these few remarks on the development of chemistry during the last fifty years, of which I know a little, it may seem presumptuous on my part in the presence of some of the most eminent chemists of our day, whose opinions must be of infinitely more value than mine, to say anything about the future of our science and the direction it will probably take. Nevertheless, trusting to your kind indulgence, I will venture on some speculations in this direction, which, if they do not instruct the younger members of the Section, may serve to amuse their seniors, and at all events will refer to subjects on which some thought is well bestowed.

As regards the future of chemistry, the question has frequently suggested itself to me as it has doubtless done to others—Will chemical science go on expanding and developing during the next few generations as it has done in the course of the last hundred years? Will discovery follow discovery, and fact be added to fact, until the record occupies not a few volumes only, but a whole library? Will systematic chemistry, *i.e.* the history and description of all possible combinations of the elements, have any limits? I am inclined to answer in the negative. All human institutions pass through the same phases; they have their rise, they culminate, and decay; and I do not see why the science of chemistry should form an exception. Moreover, it is a natural law that whatever develops rapidly also declines rapidly, and the development of systematic chemistry since the commencement of this century has been perfectly unprecedented. I think it probable that in the course of time, at the rate at which we are now progressing, nearly all possible compounds will have been prepared, all the most important chemical facts will have been discovered, and pure chemistry will then be practically exhausted, and will be in the same condition as systematic botany and mineralogy now are. New compounds will now and then be discovered, just as new plants and new minerals now are, but nothing further will be brought to light that will affect the theories at which we shall then have arrived, whatever they may be. All the material with which the science has to deal having then been brought together, what will happen? Will chemical science cease? Will chemists, satisfied with past achievements, cease to work, confining themselves to practical questions and the history of the days gone by? I think not. The science will continue to develop, but it will be in other directions than those previously pursued. The exhaustion of systematic botany has not put an end to botanical science, for vegetable physiology has opened a wide field to the botanist, one that will take a long time to explore thoroughly. To indicate the directions which chemical science will take in its various applications to other departments of knowledge, as, for instance, in connection with the study of the physical properties of matter, or in elucidation of the chemical processes whereby minerals have been formed, or those through which geological strata have passed in by-gone ages, would not be within my competency, as I should have to touch on subjects with which I am not familiar; but I may be permitted to refer by a few words to a subject, with which, by reading at least, I have become better acquainted, and which seems to me to offer a wide field to the investigator who shall come well provided with physical and chemical knowledge to its cultivation. I allude to the processes whereby the substances constituting the various organs of plants and their contents are formed, and those again to which the decomposition and decay of vegetable matter are due; a subject as to which our knowledge is quite elementary, but which, it seems to me, admits of an extension and development of which we have at present not the least conception.

De Saussure, it is well known, first discovered the fact that plants under the influence of light absorb carbonic acid and give off oxygen, the inference of course being that the carbonic acid and the water present are decomposed, the carbon of the former and the hydrogen of the latter going to form the various organic constituents of the plant, while the oxygen or a part of it is set at liberty and poured into the atmosphere. The facts as they stand are simply these: what the plant requires for its subsistence is carbonic acid, water, nitrogen in some form (presumably that of a nitrate), certain bases—potash, lime, magnesia, iron oxide, and phosphoric acid. Out of these it constructs the whole of its organic frame, its cells and their contents, re-arranging the elements of which its food consists in such a manner as to convert inorganic into organic matter, *i.e.* changing bodies in which the affinities of the atoms are thoroughly satisfied into such as contain them in a state of more or less unstable equilibrium, and therefore liable to alteration when their atoms are allowed to act in accordance with their natural affinities. More than this we do not know; our ignorance of the several steps or stages of the process, if there are any such steps, is complete; all that has been added to the general statement just given is mere speculation. Yet it is impossible to remain satisfied with the present state of our knowledge on the subject. Accordingly numerous attempts have been made to bridge over the chasm which separates the inorganic and organic worlds, not indeed to show that the change does not involve the creation, as was once supposed, of new matter—for this was proved long ago—but to exhibit in its details the hidden mechanism which produces it, but hitherto without success. We know that light is essential to the process of assimilation in plants, since this does not proceed in

he dark, but this fact does not help us to an explanation, or light in this case is a mere stimulant, and never produces the same or similar effects outside the vegetable organism. Liebig and others have attempted to show that the process of assimilation in plants commences with the formation of some simply constituted body, such as oxalic or formic acid, with the elimination of oxygen, out of which by condensation and further separation of oxygen more complex bodies, such as sugar, fats, &c., are formed; but there is not the slightest evidence at present in favour of this view. The first product of assimilation that is directly recognised is starch, a highly complex organic, we might also say an organised body, which appears at once with all its characteristic properties, like Minerva springing fully armed from the head of Jove. If we are to adhere to the facts so far observed, we must conclude that the plant does not proceed as we should do in the laboratory, beginning with the more simply constituted compounds and advancing to the more complicated, but that the reverse process is the one actually adopted, the supposed intermediate products being more probably the results of retrogressive metamorphosis. This conclusion is, however, so much opposed to ordinary chemical views that one cannot feel surprised at the constantly repeated attempts to clear up the question. There can be no doubt indeed that much here remains to be done and to be discovered.

Intimately connected with this subject is that of chlorophyll, the green colouring-matter of leaves, which is always found wherever the process of assimilation in plants is going on, and nowhere else, and is therefore doubtless an essential factor in the process. What part it plays in this process is, in my opinion, still unknown. Its action is probably in part chemical, in part physical, and this adds, it may be, to the difficulty of understanding it. It is generally supposed that it is chlorophyll which by its direct action on the carbonic acid and water with which it comes in contact leads to the formation of organic matter with elimination of oxygen. But this is, I think, a mere assumption—an error due, like many others, to a mistaken use of terms. The chlorophyll of chemists is simply an organic colouring-matter, like alizarin or indigo, but being in the vegetable cell intimately associated with other matters, vegetable physiologists have attributed to the action of one, and that the most obvious, constituent what is really due to the complex, perhaps even to some quite other constituent of the complex. It is impossible to conceive that the chlorophyll of chemists can be endowed with the remarkable and exceptional properties attributed to it by physiologists; it is a chemical entity, nothing more. It may indeed be said that chlorophyll only acts as it is stated to do when enclosed within the vegetable cell, but this merely amounts to saying that its action is not purely chemical, but is controlled by the vitality of the cell, which, I suppose, means the action of the protoplasm. If chlorophyll is the agent whereby the decomposition of carbonic acid and water is effected, how, it may be asked, is the agent itself produced? It does not come from without; the plant must be able to form it in the first instance. We are told by vegetable physiologists that the coniferæ when raised in total darkness from seeds produce chlorophyll. In light or in darkness I am convinced it is the same; the plant forms chlorophyll as a means to an end. What the end is we know; it is the assimilation of carbon and hydrogen to form organic matter. How does the chlorophyll assist in attaining this end?

In propounding a new theory in reply to this question I venture to claim your indulgence, such as has been accorded to some of my predecessors and others who at these meetings of the British Association have been permitted to make statements and use arguments of a novel or paradoxical character, which, if they effect nothing else, at least afford a relief to the usual routine of scientific reasoning. My experiments on chlorophyll have led me to infer that the constitution of that body is much less simple than it is generally supposed to be. I do not mean by this that chlorophyll is a mixture in the usual sense; everyone who has paid any attention to the subject knows that ordinary chlorophyll consists of several colouring-matters, some of which are yellow, not to mention fatty matters which are unessential. What I mean to say is this, that the pure green substance, the chlorophyll *par excellence*, does not belong to the same class of bodies as alizarin or indigo, but contains three elements, each of which is essential to its constitution, one being a basic nitrogenous colouring-matter, the second a metal or a metallic oxide, the third an acid, the three together constituting green chlorophyll. The basic colouring-matter is a body of very peculiar properties; it is the phyllocyanin of Fremy: the metal may be iron or zinc, the acid I will suppose to be carbonic acid. Now the plant having formed its colouring-matter, the metallic oxide being present in some form or other, and the carbonic acid being supplied by the atmosphere, all the necessary conditions co-exist for the formation of chlorophyll. The compound is an unstable one; it easily parts with its carbonic acid, giving it up to the protoplasm or whatever the agent may be that effects its actual decomposition under the influence of light. The advantage of this arrangement would consist in this, that the carbonic acid would be presented in a more condensed state to the agent which effects its decomposition than if it were merely contained in a watery solution, but more loosely combined, and therefore more easily accessible than if it were united to a strong base such as potash or lime. The carbonic acid having been disposed of, the other two constituents would be in a state to take up fresh quantities of carbonic acid and so on. Chlorophyll would therefore act as a carrier of carbonic acid in the plant, just as hæmoglobin serves to convey oxygen in the animal economy. Numerous objections may of course be raised to the theory of which I give an outline; I only throw it out as a tentative explanation, showing that the function of chlorophyll may be, in part at least, chemical, and that we need not suppose it to be endowed with the marvellous and exceptional powers usually ascribed to it. Other and more probable explanations will doubtless suggest themselves when this difficult subject has been more thoroughly worked out. Eventually, too, it will be found, I imagine, that physical forces as well as chemical affinities play a part in this as in every other process of the vegetable economy. In the case of chlorophyll there can be no doubt that the green colour and the peculiar behaviour towards light have something to do with its action, but on this point it is not necessary for the chemist to pronounce any opinion. I may take this opportunity of mentioning the important experiments of Sachs and Pringsheim on the optical properties of chlorophyll in their relation to assimilation in plants, as they are probably not so well known to chemists as to botanists.

What I have said may serve to show that the very first steps of the process whereby organic or organised matter is formed in plants are hardly understood. We understand still less the further steps leading to the production of the more complex vegetable bodies—acids, alkaloids, fatty matters. Granted that we were able to trace the formation in the plant of a compound of simple constitution, such as oxalic or formic acid, how far should we still be from understanding the building up of such compounds as starch, albumen, or morphia? The syntheses so successfully and ingeniously carried out in our laboratories do not here assist us in the least. We know the steps by which alizarin is artificially produced from anthracene; but can anyone for an instant suppose that the plant commences in the same way with anthracene, converting this into anthraquinone, and having acted on the latter first with acid, then with alkali, arrives at last at alizarin? Indeed the plant never contains ready-formed alizarin at all. What we observe from the commencement is a glucoside, a compound of alizarin and glucose, which, so far as we see, is not gradually built up,

but springs into existence at once. When we think of the complicated process by which indigo is produced in the laboratory with the various substances and appliances required, and then see how in the minutest seed-leaves of a plant like woad a still more complex substance, indican, is found ready-formed, we stand confounded at the simplicity of the apparatus employed by the plant, and are obliged to confess that we have no conception of the means whereby the end is attained. The same difficulties occur in other cases, and it will therefore probably be conceded that the synthetic processes carried on in plants, from the first step to the last, are not in the least understood.

It might be supposed that after all the labour and attention bestowed on the inorganic constituents of plants we should know something of the part played by these constituents in the processes of assimilation and nutrition, but here the obscurity is as great as elsewhere. We know by experiment that certain inorganic matters—potash, lime, magnesia, iron oxide, phosphoric acid—are essential to the growth of plants; but of their mode of action, or of the reason why certain plants require potash salts, others lime, and so on, we know nothing. Phosphoric acid is no doubt an essential constituent of the protoplasm of the plant; but why cellulose, of which the various organs chiefly consist, should require mineral matters, which do not enter into its composition, for its formation and building up is still a mystery.

The department of chemistry which relates to the decomposition of organic and organised matters presents problems almost as difficult of solution as those relating to their formation and building up; that is to say, the phenomena observed do not apparently obey the same laws as those prevailing in the inorganic world. When I began my chemical studies the difference in this respect between mineral and organic compounds was less clearly seen than at present. The conversion of alcohol into acetic acid, the putrefaction of animal and vegetable matter were thought to be simply due to oxidation; they were phenomena, it was supposed, exactly similar to the rusting of iron, the tarnishing of metals, the fading of colours. That a third body was required to initiate and continue the process of decomposition, that organic matter in contact with purified air would remain unchanged for any length of time—was not known nor suspected. I am not quite sure whether spontaneous decomposition—*i.e.* the splitting up of a complex body without the intervention of an external agent—might not at that time have been considered possible. In order to explain the phenomena of fermentation, the decomposition of sugar into alcohol and carbonic acid, for instance, we had only the theory of contact—devised by Berzelius and Mitscherlich, the latter of whom used to expatiate on the subject at great length in his lectures. When this ghost of a theory was laid by Liebig, who suggested an intelligible explanation of the phenomena in accordance with the facts then known, it was felt to be quite a relief, as affording a resting-place—if only a temporary one—for the mind. The brilliant researches of Pasteur, which have thrown so much light on the action of the insoluble organised ferments, I need only refer to, as they are so widely known, even outside scientific circles; and since also investigations such as his cannot be discussed without some reference to biological questions, which cannot be entered on now. I will confine myself therefore to a few remarks on the unorganised or soluble ferments, one of which I had occasion to examine when engaged in investigating madder and its colouring-matters. These ferments, the type of which is diastase—a substance found accompanying starch in the seeds of plants—are soluble in water, perfectly neutral, devoid of all definite form, and though apparently inert, able when acting within the sphere in which Nature has placed them, to cause changes and decomposition of the most profound character. Their action excludes everything in the shape of vitality, and yet it is as mysterious and unaccountable as anything that the vitality of the organised ferments is capable of effecting. Indeed, in vegetable, and especially animal, organisms they seem expressly intended for the attainment of certain ends necessary for the well-being, or even the existence, of the organism, insomuch that it has been supposed, with some show of reason, that it is to bodies of this class existing within the cells of organised ferments, but not separable by any means at our disposal, that the changes produced by the latter are really due.

A great deal of attention has been paid to the products and results of fermentation, but very little hitherto to the *modus operandi* of the ferments themselves, and yet this seems to me to offer a wide field for interesting research, especially in the case of those of the soluble class, which are easily prepared, and can be manipulated in the laboratory like any chemical substance without the tedious precautions and preliminary operations necessary in the case of the organised ferments. In what way, it may be asked, do these soluble ferments produce the effects peculiar to them? Is the action essentially chemical, or is it due to physical causes as well? Is the quantity of fermentable matter acted on by a certain quantity of ferment unlimited in amount, or are there limits to that amount somewhere? Does the ferment itself undergo any change during the process of fermentation, or is it the same afterwards as before and capable of acting on fresh quantities of fermentable matter? When a ferment is replaced by a strong mineral acid, the products of decomposition being the same, is the *modus operandi* in both cases alike, or must a different explanation be in each case sought? These questions have never been satisfactorily answered, and await solution. I know of only one attempt to show what actually takes place during a process of fermentation set up by a soluble ferment.

The experiments of Wurtz* on papaïn, the soluble ferment of *Carica papaya*, led to the conclusion that the fibrin on which it is made to act combines in the first instance with the ferment itself, the latter after the hydration of the filbrin is completed being again set at liberty, and then able to act on fresh quantities of fibrin. Thus, according to Wurtz, the action is found to be the same as that of chemical agents, properly so called, such as sulphuric acid, of which minute quantities may exert a hydrating action in consequence of the transitory formation of compounds which are constantly being produced and again decomposed.

There is another question referring to these soluble ferments to which in the present state of our knowledge it is impossible to frame a probable answer, viz., why does it so frequently happen that each ferment exerts a specific action, an action peculiar to itself, this being in fact, in the absence of any marked chemical characters, the only means by which they can be distinguished one from the other? Why does one ferment act on starch only, while the function of another consists in the hydration of fibrin, that of another in the decomposition of a glucoside, and so on? In accordance with the explanation of Wurtz, we should say that a specific ferment is one capable of combining only with the body on which it is to act, and with no other. I was led to ask this question when engaged in the examination of the colouring matters of *Rubia tinctorum*. The root of this plant, the madder of commerce, contains glucosides, which, though coloured, are quite devoid of tinctorial power. Nature has at the same time placed in the root a peculiar ferment, which, coming into contact with these glucosides at a certain temperature, effects their decomposition, splitting them up into glucose and true colouring matters. Now this ferment is a body *sui generis* and cannot be replaced by any other ferment that I have tried; its action is specific. Why Nature should have deposited this body in the recesses of the plant for the express purpose of acting on certain glucosides and forming colouring matters, the object of which, so far as

* *Comptes Rendus*, 91, 787.

the economy of the plant is concerned, can only be guessed at, is difficult to understand. One is inclined in such a case to revert to the old-fashioned doctrine that some natural processes were devised for the use and delectation of man. It is quite certain in the case of madder that had it not been for its peculiar ferment erythrozym, the valuable tinctorial properties of the root, which have for centuries been applied in the production of that splendid dye Turkey red, would have remained unknown perhaps to the present day, since the only efficient substitute for the natural ferment is a strong mineral acid, and such acids and their uses were unknown in former days.

I am inclined to think that some of the younger chemists and physiologists of to-day may live to see the time when all the at present mysterious and unaccountable processes going on in the organisms of plants and animals, including those of fermentation, will be found to obey purely physical and chemical laws. To the biologist it may seem derogatory to the dignity of his science to have the principle of vitality, which has so long reigned supreme, dethroned and replaced by hard, unbending law. Such, however, is not the opinion of that distinguished botanist Sachs, who says, referring to this very point:—"Der Organismus selbst ist nur die aus verschiedenen Theilen bestehende Maschine, die durch weitere Eingriffe äusserer Kräfte in Bewegung gesetzt werden muss: von ihrer Struktur hängt es ab, welchen Effekt diese äusseren Kräfte an ihr bewirken. Es würde einen sehr niedrigen Horizont wissenschaftlicher Bildung verrathen, in diesem Vergleich eine Herabsetzung des Organismus sehen zu wollen, denn in einer Maschine, wenn auch nur von Menschenhänden gemacht, leigt das Resultat tiefsten und sorgfältigsten Nachdenkens und hoher Intelligenz, soweit es ihre Struktur betrifft, und wirksam sind in ihr schliesslich dieselben Naturkräfte, welche in anderer Combination die Lebenskräfte eines Organs darstellen. Die Vergleichung des organischen Lebens mit unorganischen Processen kann nur dann als eine Erniedrigung des ersteren gelten, wenn man so thöricht gewesen ist, die letzteren als etwas Niedriges und Gemeines aufzufassen, während die unbegreifliche Grösse und Durchgeistigung der Natur in beiden Fällen sich gleichartig offenbart."* The time may be far distant when these views of the great botanist shall be universally accepted; but they will, I think, sooner or later prevail.

The little known territory which separates the domains of chemistry and physiology will, in my opinion, offer a wide and interesting field for research, after that of pure chemistry shall have been exhausted or lost its interest. Most important problems connected with life and its relation to the inorganic world there await solution, and I confess that I am inclined to envy the young investigator who, coming provided with an ample store of chemical and physical knowledge, shall apply himself to the solution of these problems. The pleasures derived from the successful pursuit of such studies belong to the highest and purest that we are able to conceive. I can, however, only repeat what has so often been said before, and what the young man of science should not forget, that a life devoted to research only involves no material rewards; it certainly never secures wealth, sometimes not even honour nor fame. Looked on with indifference or even dislike by the State, the Church, and the public at large, all that the man of science can certainly look forward to at the close of his career is the addition at his hands of a few stones to the vast edifice ot truth, and the consciousness of having attained a higher stage of intellectual insight.

You may probably expect me, before I conclude, to make some reference to technological matters, to the various chemical arts and manufactures for which the Manchester district is noted. At the last meeting of the British Association in Manchester a report on the condition at that time of manufacturing chemistry in the South Lancashire district, by Sir Henry Roscoe, the late Dr. Angus Smith, and myself, was laid before the Chemical Section. A similar report showing the progress made in chemical technology since that time would have been interesting. Great changes have taken place during the period that has elapsed, especially as regards the alkali trade, and quite a new branch of industry has been developed, that of the coal-tar colours. A description of these new features of our chemical industry with statistics of production would therefore have been acceptable. The idea of a report had however to be given up on account of the difficulty of obtaining reliable information as to details, and in these matters it is the details only which are interesting, the general features of the subject being well known. It can hardly be a matter for surprise, I think, that our manufacturers, considering the active competition to which they are exposed, and the disadvantages under which they labour in consequence of the exclusiveness of foreign nations, should be loth to furnish information which would benefit their rivals in trade. Several interesting papers on branches of chemical industry by gentlemen well versed in them will, however, be read before the Section, and these will, to a great extent, make up for the want of a general report. In the Chemical Section of our Jubilee Exhibition, too, you will see a very fine collection of chemical products, more extensive and beautiful, perhaps, than any previously brought together, and these will give you a good idea of our industrial activity. It would have been interesting to witness step by step some of the processes employed in the manufacture of these various products, but this, I am sorry to say, must not be expected generally.

To some it may seem that this Jubilee Exhibition shows the manufacturing industry and prosperity of this district at least at their highest state of development; that they are now at their meridian, and in the future are doomed to decline. If this be so—and there are certainly indications which seem to favour this view—it would be well for those whose visits here are only occasional to take especial note of the present state of things so as to be able to compare their impressions when they next visit us with those now received, since gradual changes in communities, as in individuals, are more patent to casual observers than to those who are always on the watch.

From some points of view the signs of the times are certainly not encouraging. It should not be forgotten that the manufacturing prosperity of this district depends to a great extent on the ample supply of a product which is brought to us at some cost from tropical and semi-tropical countries to be re-exported in the shape of manufactured goods. A political convulsion abroad, and this, unfortunately, is a casualty that may at any time be expected, or even the determination on the part of other nations to starve us out, however short-sighted such a determination might be, might cut off our supplies and disable us permanently as we were partially disabled twenty-five years ago. If to this be added the fact that foreign nations are becoming increasingly hostile and exclusive commercially, we cannot feel surprise at the dismal forebodings entertained and the confident predictions of decline uttered by some who claim to know all the facts. I ought to apologise for alluding to so gloomy a subject on the occasion of this to a great extent festive gathering, but then men of science like to look at a question not only from a hopeful but from every point of view. Fortunately on this question they are not called upon to pronounce any opinion one way or the other.

Should this be the last time that Manchester shall entertain the British Association in the day of its prosperity, I can only say with the German poet—

> Schliesst den Kreis und leert die Flaschen
> Diese Sommernächte feiernd,
> Schlimme Zeiten werden kommen,
> Die wir Auch sodann ertragen.

Whether in prosperity or adversity I feel sure that this city will always endeavour to entertain its visitors to the

* *Vorlesungen über Pflanzenphysiologie.*

best of its ability. On the present occasion I may with confidence on the part of the chemical world of Manchester offer to the many friends from near and far who honour us with their presence at this meeting a most hearty welcome.

WATER ANALYSIS.

At the meeting of the American Association for the Advancement of Science, held at New York in August last, a previously appointed Committee of Section C presented their recommendations on a plan for a uniform method of stating the results of Water Analysis.

The report was accepted and the Committee was reappointed. Two members of the Committee—Professors Langley and Clarke—attended the late meeting of the British Association, and have been the means of securing the appointment of a Committee of Section B to cooperate with the Committee of American chemists. The following is the report of the American Committee:—

"Your Committee are of the opinion that one scale for both mineral and potable waters is unadvisable: the scale that would be desirable in order to avoid the use of too large numbers in stating the composition of a mineral water would necessitate the use of inconveniently small decimals in the statement of the composition of a potable water, or one examined for sanitary purposes.

"The Committee therefore recommend the adoption of two schemes, as follows:—

I.

"*Scheme for a Mineral Water.*

"*a.* That the composition be expressed in parts per thousand, by weight.

"*b.* That the parts per thousand of each basic element, K, Na, Li, Ca, Mg, Fe^{II}, (Fe_2^{IV}), &c., be given, and of each acidic element, Cl, S, I, &c., that is combined directly with a basic element or that may reasonably be supposed to be so combined: the rest of the acidic elements to be given in connection with all the oxygen of their salts as usually written in our present empirical formulas, as CO_3, SO_4, PO_4, &c.

"*c.* That these constituents be arranged in electrochemical order, the positive ones being given first.

"*d.* That the volume of O, CO_2, and of H_2S expelled on boiling be given in cubic centimetres per litre of water.

"*e.* That the combination deemed most appropriate by the chemist making the analysis be stated, both by names and by symbols.

II.

"*Scheme for a Water Examined for Sanitary Purposes.*

"The composition shall be expressed in parts per million (milligrammes per litre) as illustrated below:—

Total solids	
Chlorine	
Nitrogen expelled on boiling with Na_2CO_3	
,, equals 'free ammonia'	
,, expelled in boiling with alkaline $KMnO_4$	
,, equals albumenoid ammonia	
,, as nitrite	
,, as nitrate	
Organic matter (expressed in terms of milligrammes of O consumed by one million of the water)	
Hardness	

"The manner of expressing the results on organic matter must depend somewhat upon the method of its estimation.

"The scheme for mineral waters is, in its essential or non-important general features, the same as that recommended by a Committee of the Washington Chemical Society in a Report to that Society, and which was made the subject of a Paper read before Section C at the Buffalo meeting of the A.A.A.S."

ON THE ANALYSIS AND PROPERTIES OF PHOSPHORISED SILVER.

By H. N. WARREN, Research Analyst.

During the reduction of argentic phosphate by means of charcoal, and using calcium borate as a flux, on examination of the reduced metal it was observed to possess a decided yellow tint, resembling in every respect silver containing about 25 per cent of gold, and at the same time retaining a perfect malleability similar to pure silver, although after fusion refusing to spit on cooling. On submitting the same to a careful gravimetric analysis the mean of several estimations were as follows:—

Silver	95·42
Sulphide of silver	4·30
Gold	0·38
Phosphorus	traces
	100·10

The sulphide of silver present apparently becoming introduced on account of the calcium borate used to flux the metal containing calcium sulphate, which, on being subjected to a high temperature, becomes partially reduced by means of the charcoal. The sulphide of silver existing in the regulus, however, apparently played no part in transmitting a yellow colour to the silver, which was afterwards confirmed by taking pure silver, and introducing phosphorus in small pieces when in a fluid state; the silver, on cooling, apparently throwing off the whole of the phosphorus in the form of small jets, which burnt lively on the surface of the metal, the silver at the same time, however, retaining sufficient phosphorus to prevent its spitting on cooling and to produce a decided yellow tint, although the average result as regards the percentage of phosphorus in the same seldom exceeded 0·002 per cent: this quantity of phosphorus, although so minute, is exceedingly difficult to expel by means of cupellation, often requiring from three to four consecutive cupellations with lead before leaving the silver possessed of its natural properties.

RELATIONS OF MERCURY TO OTHER METALS.

By A. C. COUSINS.

Since my first paper on mercury, I have noticed other relations between that metal, gold, and thallium, which are interesting, and if not accidental may possibly lead to the discovery of an important law.

The atomic weights and specific gravities are those previously given, and are the most recent determinations I have been able to obtain:—

	Sp. gr.	Atomic Weight.	Atomic Volume.
Gold	19·263	196·2	10·181
Thallium	11·86	203 6	17·167
Mercury, liquid	13·598	200·0	14·708
,, solid	14·39		

It will be seen that not only is the atomic weight of mercury the mean of that of gold and thallium, but its specific gravity in the liquid state is very nearly the mean of their atomic volumes; and its own atomic volume is

almost exactly the theoretical specific gravity of an alloy formed of equal weights of gold and thallium, the calculated specific gravity being 14·68, which is only 0·29 in excess of the specific gravity of solid mercury.—*Oil, Paint, and Drug Reporter.*

NOTICES OF BOOKS.

Physico-Chemical Constants. Melting- and Boiling-Point Tables. By Thomas Carnelley, D.Sc. (London), B.Sc. (Vict.), F.C.S., F.I.C. Vol. II. London: Harrison and Sons.

This second volume of Tables of Melting- and Boiling-Points completes—as the author tells us, and as we can well believe—a labour of ten years. It contains upwards of 32,000 melting- and boiling-points, making up, with those given in Vol. I., a total of over 51,000.

The arrangement adopted is that of compounds containing respectively four, five, six, seven, and eight elements; those containing special elements. Each page gives in parallel columns first the name of the compound in question, then its constitution, its formula, boiling-point, melting-point, the authority for the determinations, reference to the Journals or Transactions where the Memoirs originally appeared, and a further reference to "Watts's Dictionary" and to the *Journal of the Chemical Society*.

The third part comprises tables of the vapour-tensions and boiling-points of simple substances; corresponding tables for mixed liquids and saline solutions; freezing and melting-points of mixtures, including cryohydrates; miscellaneous melting- and boiling-point data, such as melting- and boiling-points of fats and oils. Lastly follow the volumes and corresponding years of issue of the more important chemical and physical periodicals, and an alphabetical index of root carbon compounds.

It would be difficult to name a more meritorious and a more *self-denying* work than the one before us,—one that for so many years of labour will return the author so little in the way of *kudos*. Not alone the general public will take no notice of the book, but even physicists and chemists—to whom it will save frequent trouble and expenditure of time—will, we fear, feel little gratitude to the author. The more honour, therefore, is due to Dr. Carnelley on the part of all who have the welfare of Science really at heart.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 5, August 1, 1887.

On Thorium Silicates.—L. Troost and L. Ouvrard.—The authors have previously shown that the study of the double phosphates formed by thorium and zirconium with phosphoric acid and potassium or sodium furnishes no argument for approximating thoria and zirconia. The study of the combinations of thoria with silica shows us a compound in which this base seems to deviate still more widely from zirconia. The composition and the crystalline form of thorium silicate tend to remove this base from zirconia just as the composition and the crystalline form of thorium metaphosphate remove it from silica, to which it had been formerly approximated.

New Fluorescences with Well-defined Spectral Rays.—Lecoq de Boisbaudran.—Alumina, containing 1-1200th of samaria, after powerful ignition with the gas-blowpipe, give a very fine orange fluorescence, which is still more brilliant with 1-50th of samaria. The effect of the previous application of a very high temperature upon chromiferous alumina and samariferous alumina is the same. There is an enormous increase of lustre, the production of narrow rays, and a transfer of the maximum illumination towards the red.

Fluorescence of Spinel.—Lecoq de Boisbaudran.—The author maintains that the red fluorescence of spinels is due to chrome, and their green fluorescence to the presence of manganese.

Spectra of Didymium and Samarium.—Eug. Demarçay.—The author has observed among among the products of the fractionation of praseodymium the band $\lambda=469$ (of equal strength to $\lambda=444$) with very different intensities, and concluded hence that $\lambda = 469$ did not belong to praseodymium. On further fractionation he confirms his former observation, but not the conclusion which he drew. We see in the fractions which no longer give a trace of the band $\lambda=444$ characteristic of praseodymium a narrow band $\lambda = 469{\cdot}8$, well-defined and resembling the ray 427·5 of didymium. This band therefore does not belong to praseodymium. On the other hand in the purest portions of praseodymium containing merely a little lanthanum, we observe a very strong but nebulous and diffused band about $\lambda = 469$ of an aspect very different from the foregoing. We must therefore conclude that these bands have a similar wave-length, but are distinct from each other, the former belonging to a body still unknown. In portions of neodymium pure from praseodymium and containing only little samarium, there are found some rays not yet described: (1) $\lambda=464$ about, a very narrow ray at the more refrangible margin of the corresponding nebulous ray of didymium; (2) $\lambda=430$, a narrow and rather faint ray. M. Soret has mentioned a doubtful ray about this place; (3) $\lambda=476$ about, of the spectrum of didymium appears in a nitric solution formed of a strong double ray, of which the more refrangible component is the more intense. The author maintains that in *Comptes Rendus*, cii., p. 1551, and civ., p. 580, he has anticipated the discovery of Krüss and Nilson that samarium consists of at least two simple bodies.

Formation-Heat of Certain Crystalline Tellurides.—Ch. Fabre.—The author concludes that in one and the same family as the equivalent weight of a non-metal combined with a metal increases the quantity of heat liberated on combination declines.

Succinimido-acetic and Camphorimido-acetic Ethers.—A. Haller and G. Arth.—This paper does not admit of useful abstraction.

A New Isomer of Benzene.—G. Griner.—This compound is a solid which melts at 64° and distils about 129° to 130°. It plays the part of a non-saturated body. If dissolved in carbon disulphide it fixes in the cold 4Br.

Remarks on the Observations presented by M. Grawitz on the Preparation of Aniline Chromates and their Applications.—Ch. Girard and L. L'Hote.—No one before the authors had isolated and studied aniline dichromate, a crystalline salt of which they have given the formula and the chemical properties. This bichromate in a state of purity, contrary to the pretensions of M. Grawitz, can be isolated only on operating with an acid solution of an aniline salt.

On a New Microbe, determining the Indigotic Fermentation and the Formation of Indigo Blue.—E. Alvarez.—The author concludes that indigo is a fermentation-product. This formation is determined by a special micro-organism, which is a capsuled rod having the greatest resemblance to those of pneumonia and rhinoscleroma, which latter equally give rise to the indigotic fermentation. The indigo bacillus has pathogenous properties, and may occasion in the animal system either

a transient local inflam nation or rapid death with visceral congestion and fibrinous exudations.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 4th Série, Vol. ii., No. 17, May, 1887.

Report presented by E. P. Bérard on behalf of the Committee of the Chemical Arts on the Cryptographic Procedures of Prof. Schlumberger.—The object of the invention is to furnish proof of the genuine character of share-certificates and bonds, and to prevent alterations in the figures of cheques.

Wines and Brandies from Raspberries and Strawberries.—A. Rommier.—From the *Comptes Rendus.*

The Sugaring of Musts and the Manufacture of Sugar Wines.—MM. Klein and Fréchou.—From the *Comptes Rendus.*

No. 18, June, 1887.

Report presented by M. Biver on a System of Melting Furnaces for Glass Works with Recovery of Heat, devised by M. Charneau.—This paper requires the accompanying figures, which have been placed by mistake in No. 17.

Revue Universelle des Mines, de la Metallurgie, &c., Vol. xxi., No. 2, March and April, 1887.

Aluminium and its Alloys; the Processes of H. and A. Cowles and Dr. Mabery.—R. Van Langhenhove.—The author points out the superiority of aluminium bronze over common bronze and steel for the manufacture of artillery. Its higher price is more than compensated by its lightness and its greater resistance, which is about triple that of ordinary bronze.

MISCELLANEOUS.

City and Guilds of London Institute.—Technological Examinations.—The following is a summary of the mor mportant alterations and additions which have been in.roduced into the Programme of Technological Examinations for the year 1887 8, and of other matters to which the attention of Teachers and Secretaries is especially directed:—1. The grant made to teachers on account of students who are awarded the Full Technological Certificate in the Honours Grade of any subject is £3 for a 1st class and £2 for a 2nd class certificate. 2. The examination in subject 29, Carriage Building, will consist of two parts. Section I. will be devoted to Road Carriages, and Section II. to Rail Carriages. 3. The syllabus of subject 16 B, Boot and Shoe Manufacture, has been reconstructed with special reference to the requirements of the trade in London, Leicester, and Northampton. 4. The syllabus in subjects 2, Bread Making, and 3 A, Brewing, are new, and a practical test has been added to the Honours examination in Bread Making. 5. In addition to the written examination in Typography, a practical test for Compositors will take place on the afternoon of Saturday, May 26th, 1888, at the following, and possibly at other, centres:—Aberdeen, Messrs. G. Cornwall and Sons; Ashford, Messrs. Igglesden and Son; Belfast, Messrs. Marcus Ward and Co., and Messrs. McCaw Stevenson and Oar; Birmingham, Mr. Alderman Wnite; Derby, Messrs. Bemrose and Sons; Glasgow, Messrs. Blackie and Sons; Greenwich, Messrs. Merritt and Hatcher; Guildford, Messrs. Billing and Sons; Haverfordwest, ——; Lincoln, Messrs. Akrill, Ruddock, and Keyworth; Liverpool, Messrs. Marples and Co.; London, Messrs. Cassell and Co. (Limited), Messrs. Waterlow and Sons (Limited), and Messrs. Clowes and Sons; Manchester, Co-operative Printing Society; Norwich, Messrs. Fletcher and Son; South Shields, Messrs. Simpson and Sons, and Mr. W. D. Learmount. 6. Candidates in either grade of Plumbers' Work may, in addition to the written examination in that subject, present themselves for a practical examination, to be held on the afternoon of Saturday, the 26th of May, 1888, in London, or at some other centre at which the Intitute's Examiner can attend, or at which a Local Assistant has been appointed. (Candidates who pass the practical examination in Plumbers' Work, and in other subjects in which the practical examination is optional, will receive a special certificate.) 7. The examination in all branches of subject 19, "Textile Fabrics," and in "Weaving and Pattern Designing," will be held on the afternoon of Saturday, May 26th, 1888, from 3 to 7. 8. The syllabuses of all other subjects have been carefully revised, and several important alterations have been made in some of them, particularly in subject 34, Carpentry and Joinery. 9. Additions have been made to the "Works of Reference" in several subjects. 10. Rule 22 of the Programme as to production of employer's certificate has been somewhat altered. 11. The programme contains a list of registered teachers of the Institute, and of the subjects of instruction in which they are severally registered. For the addresses of these teachers application should be made to the Office of the Institute, Exhibition Road, London, S.W.—Philip Magnus, Organising Director.

Royal Jubilee Exhibition, Manchester. — The Geissler Institute of Bonn, Germany (Dr. Geissler's Nachfolger, Franz Müller), exhibits many new instruments and ingenious examples of the glassblower's art which will excite the interest of all visitors. There are several sets of lecture apparatus for physics and chemistry; Geissler's mercury pump, fitted up with one desiccating apparatus and two receivers, for the analysis of the gases in blood; Geppert's and Pflüger's receivers. The Geissler pump is largely used by Electric Light Companies. The Jablochkoff Company, St. Petersburg, for instance, works with this kind of vacuum apparatus. Of still more general interest are several Crookes, Geissler, and Puluj tubes, especially the new form of Crookes No. 4, containing rhombs of phosphorescent minerals which give most brilliant effects, Puluj's apparatus, and a new electrical radiometer which has phosphorescent wings. A series of chemical standard thermometers, representing together the scale from $-10°$ to $+360°$ C., each degree divided into $\frac{1}{5}°$. They are exceedingly fine and correct instruments, and handy for working with small quantities of liquids, as they are very short and thin. These standard and all other fine chemical thermometers are made of Jena normal glass. A series of medical thermometers includes a controllable instrument with the zero point graduation. Every physician should have one of these sure and easily corrected fever thermometers. There is a hypsometer baro-thermometer whose thermometer is divided into 1-100th of a degree. This extremely sensitive apparatus marks differences of height of 2 metres. The well-known vaporimeter of Dr. Geissler for the determination of alcohol in wine, beer, and vinegar, is still little employed in England. For manufacturers of soda manure, gunpowder, and dynamite, we see Lunge's nitrometer, Bunte's burette, and a series of other burettes (Hildesheimer), pipettes, graduated jars, cylinders, flasks, &c. Very interesting as fine glass blowing work are the apparatus of Norblad for sulphuretted hydrogen gas; of Brögger Harada, for the petrographical works of mineralogists; three series of Geissler stopcocks, of various forms and sizes; Pflüger litre flasks, for mixtures or dilutions of liquids, may be recommended to all chemical and physiological laboratories; Bennert's desiccator and manometer, with stopcocks and movable looking-glass scale, are both well made and practical apparatus for chemists. The thermometers, areometers, pyknometers (specific gravity bottles) with or without thermometer, of the Geissler Institute, are so

well known that we need only say the collections are of high and general interest. There are also some indications of the fact that Mr. Franz Müller keeps a large stock of metal work for chemical use, and, of course, of all apparatus and utensils which are necessary for the laboratories of chemical works and universities. As it is neither necessary nor possible in a small case to exhibit these accessories, we see only a set of chemical vessels of pure nickel, evaporating basins, crucibles, tongs, spoons, spatulas, &c.; Prof. Arzberger's gas regulator, of nickeled brass, and some more of this kind, Lists of all these exhibits contained in the show-case are placed in a conspicuous position on the stand (No. 713, main building).

Assay of Vulcanised Caoutchouc.—E. Donath (*Chem. Industrie*) shows that vulcanisation is not a phenomenon of a purely chemical order. He gives methods for the determination of the mineral substances and of the sulphur.

The Naphtha Industry: Exhibition at St. Petersburg.—The Organisation Committee of the Exhibition of Contrivances and Materials used for Lighting Purposes, and also of everything connected with the Naphtha Industry, which will take place in the winter of the present year at St. Petersburg, bring to public notice, for the information of those who desire to participate in the Exhibition, that applications will be received till the 27th of September and the exhibits till the 27th of October.

CITY AND GUILDS OF LONDON INSTITUTE,
FINSBURY TECHNICAL COLLEGE.

DAY DEPARTMENT FOR STUDENTS
Not under Fourteen Years of age.

The College Courses of Instruction in Laboratory, Lecture-room, Workshop, and Drawing Office, for Mechanical Engineers, Electrical Engineers, Technical Chemists and Builders, commence on Tuesday, October 4th.

Chemical Laboratories specially organised for instruction Technical manufacturing processes.

Fee for Session, inclusive of Laboratories, Workshops, and Drawing Office, £9.

The Entrance Examination will take place on Thursday, September 29th, at 10 o'clock a.m.

Scholarships of £30 a year each, and the Holl Scholarship of £20 a year, all tenable for two years, will be awarded (in accordance with the several schemes) on the results of the Entrance Examination.

For particulars of Scholarships and programmes of instruction apply at the Technical College, Leonard Street, City Road, E.C. or at Gresham College, E.C.

PHILIP MAGNUS, Organizing Director.
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UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE.

DEMONSTRATOR AND ASSISTANT LECTURER IN CHEMISTRY. Stipend £120 a year.

ASSISTANT LECTURER IN MATHEMATICS. Stipend £100 a year.

The above appointments are now vacant. Applications, together with testimonials, must be sent in on or before Saturday, October 8th, 1887, to the undersigned, of whom all further particulars may be obtained.

IVOR JAMES,
Registrar.

Cardiff, September 6, 1887.

OWENS COLLEGE, VICTORIA UNIVERSITY, MANCHESTER.

1. ARTS, SCIENCE, and LAW DEPARTMENT.
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3. DEPARTMENT for WOMEN.
4. EVENING CLASSES DEPARTMENT.

Prospectuses of the above Departments and of Entrance Scholarships and Exhibitions (twelve in number, and varying from £12 to £100 per annum) will be forwarded on application to the Registrar of the College, or may be obtained from Mr. J. E. Cornish, 33, Piccadilly, Manchester.

HENRY WM. HOLDER, M.A., Registrar.

PATENT Wanted to Purchase.—An untried one not objected to, but must be likely to have large sale.—Address, D., 43, care of C. Birchall, Advertising Agent, Liverpool.

TRANSYLVANIAN, HUNGARIAN, AND OTHER EUROPEAN MINERALS.

PROF. A. E. FOOTE having just returned from a very extended trip through Europe, in which he visited Nagyag, Schemnitz, Kremnitz, and many other mining localities, offers Crystallised Gold, Crystallised Nagyagite, Sylvanite, Basite, Amethyst, Herrengrundite, Rhodochrosite in crystals and polished concentric layers, and the lovely "Himbeerspath." Cronstedtite, Pucherite, Native Tellurium, Cerussite, Tetrahedrite, Bournonite, Natrolite, Axinite, Schneebergite, Alexandrite, Green Calamine, Adamine, Anatase, Turnerite, Baverno Orthoclase, and over 100 other species, numbering several thousand specimens. These will be for sale at the

AMERICAN EXHIBITION,

where also are the Malachites banded with Azurites, that have so often been referred to in the London daily papers, Wulfenites, and other things before mentioned in the advertisements.

NEW ARRIVALS.

Bright red, beautifully terminated, Vanadinites from Arizona. We have just received a few of these that we can sell at 1s. upward, the lowest price they have ever been sold at. Also some very choice yellow Wulfenite from New Mexico. Also another lot of the beautiful Marcasite and ruby-coloured Blende; also Franklinite, Zincite, Rhodonite, &c., &c.

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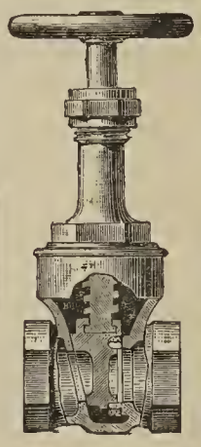

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BIRMINGHAM SCHOOL BOARD.

The Board requires the Services of an Assistant-Master for the Birmingham Bridge Street Seventh Standard Technical School. Salary £120 per annum. It is essential that the person appointed should be thoroughly qualified in Mathematics, Chemistry, and Physics.

Applications, enclosing copies of Testimonials, to be sent in on or before the 14th day of September, addressed to the Clerk of the School Board, Edmund Street, Birmingham.

THE CHEMICAL NEWS.

Vol. LVI. No. 1451.

ADDRESS TO STUDENTS.

The facilities for the study of chemistry are becoming more abundant and, in some respects at least, more efficient. There is even a possibility that at no distant date these opportunities will be still further extended, and that "chemistry for the million" will become a serious fact. But we cannot advise the young to avail themselves of the facilities offered witnout making certain reservations. We must ask the student, or rather prompt him to ask himself, what are his motives and aims in taking up the pursuit of chemistry, and not to be content without a definite answer.

If his purpose is mental cultivation; if he seeks to acquire the power of learning from things, of cross-questioning nature, or as it might be put, of observing accurately and drawing correct conclusions from his observations, we bid him go on and prosper. He will find chemistry an excellent—under many circumstances perhaps the most excellent—discipline for attaining this end.

Or, if he is born to an independent position and, possessing good abilities, purposes devoting his life to research, we would still more strongly encourage him to persevere. There is an endless quantity of work not directly remunerative, but of the highest importance, which requires to be done. Such work requires an unlimited command of time, and can, therefore, be undertaken only by persons in the position we have just mentioned. For these persons to embark in business is simply high treason against Science and against the progress of the human race.

Or, again, a young man may have before him the prospect of succeeding to the proprietorship of or a share in a brewery, a print-works, an alkali-works, or some other of the many kinds of industrial establishments which depend more or less upon chemical principles for their success. It is surely not needful to explain that in all these cases common prudence will make the acquisition of sound chemical knowledge imperative. To all such persons we should recommend not merely to aim at a special knowledge of some one part of the science which bears most directly upon their intended calling, but rather, and as a ground work, a sound general mastery of the entire science, upon which a more special and minute insight into their own department may be superinduced.

There are, again, professions in which a knowledge of chemistry is necessary. This has long been recognised with regard to medical men. The more clearly the processes, healthy or morbid, observed in the living body are understood, the more does the physician who is not a chemist feel himself at a loss.

To a less, though an increasing extent, is this the case with the legal profession. We shall not be accused of acting on the "nothing like leather" principle, if we recommend the study of chemistry to incipient solicitors and barristers. Questions concerning the validity of patents, concerning adulterations, nuisances, poisoning, &c., come before the courts often enough to render chemical knowledge useful to the lawyer.

The school-master is, in these days, often expected to teach chemistry, and he will, as a rule, not succeed in teaching what he has never learnt.

To all these different classes of persons we can give our heartiest encouragement. But there is another class, and we have every reason to fear a numerous one, to whom we can only say: Refrain! At one time it seemed likely that there might spring up a profession by means of which chemists would be able to earn a respectable livelihood by the practice of analysis, and by undertaking chemical investigations. From a variety of causes this prospect has proved a mere illusion. Chemists have been trained in such numbers that the supply exceeds the demand, and in addition there is the constant influx of foreigners, who sometimes offer their services gratuitously for half a year or more. In fact, really well-trained chemists, except they possess a practical knowledge of some one or other of the chemical arts, or enjoy special influence, are a drug in the market. The consequence is that these gentlemen have to put up with rates of payment below that of average working men. It is truly painful to us to read over the numerous letters which we receive asking for advice or recommendation. The writers can often produce excellent certificates, but there is no demand for their services. We are compelled, therefore, to advise young men to think twice before entering upon the study of chemistry as a profession.

UNIVERSITIES AND COLLEGES.

UNIVERSITY OF LONDON.

Candidates for any Degree granted by this University are required to have passed the Matriculation Examination, to which no candidate is admitted unless he has produced a certificate showing that he has completed his sixteenth year.

The Fee for this examination is £2.

There are two Examinations for Matriculation in each year; one commencing on the second Monday in January, and the other on the third Monday in June. The Examination is conducted by means of Printed Papers; but the Examiners are not precluded from putting, for the purpose of ascertaining the competence of the Candidates to pass, *viva voce* questions to any Candidate in the subjects in which they are appointed to examine.

Candidates are not approved by the Examiners unless they have shown a competent knowledge in each of the following subjects:—Latin. Any two of the following Languages:—Greek, French, German, and either Sanskrit or Arabic. The English Language, English History, and Modern Geography. Mathematics. Natural Philosophy. Chemistry.

The Examination in Chemistry is—Chemistry of the Non-metallic Elements; including their compounds—their chief physical and chemical characters—their preparation—and their characteristic tests.

A Pass Certificate, signed by the Registrar, will be delivered to each Candidate who applies for it, after the Report of the Examiners has been approved by the Senate.

If in the opinion of the Examiners any Candidates in the Honours Division of not more than Twenty years of age at the commencement of the Examination possess sufficient merit, the first among such Candidates will receive an Exhibition of thirty pounds per annum for the next two years; the second among such Candidates will receive an Exhibition of twenty pounds per annum for the next two years; and the third will receive an Exhibition of fifteen pounds per annum for the next two years; such exhibitions are payable in quarterly instalments,

provided that on receiving each instalment the Exhibitioner declares his intention of presenting himself either at the two Examinations for B.A., or at the two Examinations for B.Sc., or at the Intermediate Examination in Laws, or at the Preliminary Scientific M.B. Examination, and Intermediate Examination in Medicine, within three academical years from the time of his passing the Matriculation Examination.

Under the same circumstances, the fourth among such Candidates will receive a prize to the value of ten pounds in books, philosophical instruments, or money; and the fifth and sixth will each receive a prize to the value of five pounds in books, philosophical instruments, or money.

Any Candidate who may obtain a place in the Honours Division at the Matriculation Examination in January is admissible to the Intermediate Examination either in Arts or in Science in the following July.

INTERMEDIATE EXAMINATION IN SCIENCE.

The Intermediate Examination in Science will be held in July, 1888.

No Candidate (with the exception of such as have obtained Honours at the Matriculation Examination in the preceding January) is admitted to this Examination within one academical year of the time of his passing the Matriculation Examination.

The Fee for this Examination is £5.

Examination for Honours.

Candidates for Honours in Chemistry will be examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition, they will be examined practically in Simple Qualitative Analysis. This Examination will consist of six hours' examination by two printed papers and of six hours' practical work.

In the Examination for Honours, the Candidate, not being more than 22 years of age at the commencement of the Pass Examination, who most distinguishes himself will receive an Exhibition of £40 per annum for the next two years.

B.Sc. EXAMINATION.

The B.Sc. Examination will be held in October.

Candidates for this Examination are required to have passed the Intermediate Examination in Science at least one academical year previously.

The Fee for this Examination is £5.

Examination for Honours.

The examination for Honours in Chemistry will take place on Monday and Tuesday in the week following the Examination for Honours in Mathematics; on Monday by printed papers (chiefly on Organic Chemistry), and on Tuesday by practical exercises in Simple Qualitative and Quantitative Analysis.

The candidate, being not more than 23 years of age, who most distinguishes himself in Chemistry, will receive £50 per annum for the next two years, with the style of University Scholar.

DOCTOR OF SCIENCE.

The examination for the Degree of Doctor of Science takes place annually within the first twenty-one days of June.

No candidate is admitted to the examination for the Degree of D.Sc. until after the expiration of two Academical Years from the time of his obtaining the Degree of B.Sc. in this University.

The Fee for this Examination is £10.

PRELIMINARY SCIENTIFIC (M.B.) EXAMINATION.*

This Examination takes place twice in each year,—once, for Pass and Honours, commencing on the third Monday in July; and once for Pass Candidates only, commencing on the third Monday in January.

No Candidate shall be admitted to this Examination unless he shall have passed the Matriculation Examination, nor unless he have given notice of his intention to the Registrar at least one calendar month before the commencement of the examination.

The Fee for this examination is Five Pounds.

EXAMINATION IN SUBJECTS RELATING TO PUBLIC HEALTH

A Special Examination will be held in December in subjects relating to public health.

No candidate is admitted to this Examination unless he has passed the Second Examination for the Degree of Bachelor of Medicine in this University at least one year previously; nor unless he shall have given notice of his intention to the Registrar at least two calendar months before the commencement of the Examination.

The Fee for this Examination is £5.

UNIVERSITY OF OXFORD.

Waynflete Professor of Chemistry.—W. Odling, M.A., F.R.S.

Every Student must reside in one or other of the Colleges or Halls, or in licensed lodgings, for a period of three years, passing at least two examinations in Arts, and one in either Mathematics, Natural Science, Law, Modern History, or Theology, when, if he obtain a first, second, or third class, he can take his B.A. Degree; if he do not gain such honour he has to pass a third examination in *Literis Humanioribus*.

The fee for students working in the Laboratory for three days in the week during the Term is £3; for students working every day, £5.

Scholarships of about the value of £75 are obtainable at Christ Church, Magdalen, and other colleges, by competitive examination in Natural Science.

More detailed information may be obtained from the University Calendar; from the professors; from E. Chapman, Esq., M.A., Frewin Hall; and from the Sub-Librarian in the Radcliffe Library or the Museum.

UNIVERSITY OF CAMBRIDGE.

Professor of Chemistry.—G. D. Liveing, M.A., F.R.S.

Jacksonian Professor of Natural and Experimental Philosophy.—J. Dewar, M.A., F.R.S.

The Student must enter at one of the Colleges, or as a Non-collegiate Student, and keep terms for three years by residence in the University. He must pass the previous examination in Classics and Mathematics, which may be done in the first or second term of residence, or, through the Oxford and Cambridge Schools Examination Board, or through the Senior Local Examinations, before commencing residence. He may then proceed to take a Degree in Arts, either continuing mathematical and classical study, and passing the ordinary examinations for B.A., or going out in one of the Honour Triposes.

The scholarships, ranging in value from £20 to £80 a year, are chiefly given for mathematical and classical proficiency. Scholarships are given for Natural Science in Trinity, St. John's, St. Peter's, Clare, Christ's, Sidney, Pembroke, Caius, and Downing Colleges; the examinations being at Easter, and in June and October.

The Chemical Laboratory of the University is open daily for the use of the Students. The Demonstrators attend daily to give instructions.

Non-collegiate Students are allowed to attend certain of the College Lectures and all the Professors' Lectures, and have the same University status and privileges as the other Students. Full particulars may be obtained by forwarding a stamped directed envelope to the Assistant Registrar, Cambridge, or from the *Cambridge University Calendar*.

UNIVERSITY OF DUBLIN.

TRINITY COLLEGE.

Professor of Chemistry.—J. Emerson Reynolds, M.D. F.R.S.

Assistant Lecturer.—Augustus E. Dixon, M.D., F.C.S.

Demonstrators.— William Early, F.I.C., and Emil A. Werner.

* Candidates who pass in all the subjects of the Preliminary Scientific (M.B.) Examination, and also pass *at the same time* in the Pure and Mixed Mathematics of the Intermediate Examination in Science, or who have previously passed the Intermediate Examination in Arts, are admissible to the B.Sc. Examination.

The general Laboratories now include working accommodation for 120 Students, and the Quantitative and Research Laboratories for about 40 Students. The new Lecture Hall provides full accommodation for 340 Students. Lectures will commence on November 1st.

The Laboratories and the Lectures of the Professor of Chemistry can now be attended by Students who do not desire to reside in the University or proceed to its Degrees.

The full Course of General and Analytical Chemistry occupies three years, but a Student is free in his third year to devote most of his time to a special department of Pure or Technical Chemistry. Students can enter for any portion of the Course. The following Lectures are delivered:—

1. *Inorganic Chemistry and Chemical Philosophy.* — Elementary, first year; advanced, second year.
2. *Organic Chemistry.* — General, second year; advanced, third year.
3. *Metallurgy.*—A Course for Engineering and Technical Students.

The Laboratories are open every day from 10 to 5 o'clock (except Saturdays, when they close at 1 o'clock).

The Summer Course of Practical Chemistry for Medical Students begins during the first week in April and terminates with the first week in July.

KING'S COLLEGE.

(DEPARTMENT OF ENGINEERING AND APPLIED SCIENCE.)

Professor of Chemistry.—C. L. Bloxam, F.C.S.

Demonstrator of Practical Chemistry.—J. M. Thomson, F.C.S.

Assistant Demonstrator.—G. S. Johnson, F.C.S.

On Tuesday and Thursday at 10.20 a.m. Students of the First Year are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a View of the Forces which concur to the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic elements and their principal Compounds are described.

The Metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts; and the processes of the different Manufactures, of Metallurgy, and of Domestic Economy, are explained and illustrated.

Examinations of the Class, both *vivâ voce* and by written papers, are held at intervals during the course at the usual Lecture hour.

Second Year.—Students attend in the Laboratory twice a week, on Tuesday and Friday, at 10.20, and they go through a course of Manipulation in the most important operations of Chemistry, including the first steps of Analysis.

Any Student of this Department may be admitted to this Class at any period of his study on payment of an extra fee.

Experimental and Analytical Chemistry in the Laboratory.—The object of this Class is to afford to Students who are desirous of acquiring a knowledge of analysis, or of prosecuting original research, an opportunity of doing so under the superintendence of the Professor and Demonstrator; Students may enter, upon payment of extra Fees, at any time except during the vacation, and for a period of one, three, six, or nine months, as may best suit their convenience. The laboratory hours are from ten till four daily, except Saturday, on which day the hours are from ten till one.

In addition to the Laboratory Fee, each Student defrays the expenses of his own Experiments. The amount of this expense, which is comparatively trifling, is entirely under his own control.

Special hours and fees are arranged for the convenience of such Third Year Students as wish to study Analytical Chemistry.

Fees.—Chemistry per term, £3 3s. od.; per ann., £8 8s. od.; Practical Chemistry per term, £4 4s. od.; per ann., £10 10s. od.; Experimental and Analytical Chemistry—One Month (daily attendance), £4 4s. od.; Three Months (daily attendance), £10 10s. od.; Six Months (daily attendance), £18 18s. od.; Nine Months (daily attendance), £26 5s. od. A student taking a month's ticket may attend daily during 1 month, or 3 days a week during 2 months, or 2 days a week during 3 months.

Rules as to Admission of Students.

I. The Academical Year consists of Three terms: Michaelmas Term, from beginning of October to the week before Christmas; Lent Term, from the middle of January to the week before Easter; Easter Term, from Easter to the beginning of July.

II. The days fixed for the Admission of New Students in the Academical Year 1887-88, are Tuesday, October, 4, Tuesday, January 10, and Wednesday, April 18.

METALLURGY.

Professor.—A. K. Huntington, F.I.C., F.C.S., &c.

Demonstrator.—W. G. McMillan.

The following subjects are treated of in the Lectures: The Selection and Economic Preparation of Fuel and of Refractory Materials; the methods by which metals are obtained from their ores, and the means by which they are rendered suitable for the various requirements of the Arts.

Particular attention is made to the study of the Nature and Properties of Metals and Alloys available for Constructive Purposes.

In the Metallurgical Laboratory, which is always open during College hours, the relation between the Chemical Composition of Metals and their Mechanical Properties may be studied by the aid of Testing Machinery. The instruction given to each student is regulated by his special requirements.

Two courses of lectures will be delivered on Monday evenings by Mr. W. G. McMillan, in which especial attention will be devoted to the requirements for the examination of the City and Guilds of London Institute, viz., a Course on the "Properties of Metals and Alloys and their Uses in the Arts," and a Course on "Fuels, their Uses and Economy." A Practical Metallurgical Class will be held on Friday evenings, at which students may prepare for the examination of the Science and Art Department in Practical Metallurgy.

EVENING CLASSES.

Classes for Evening Instruction in various subjects are held during the months from October to March, inclusive, and during the months of April, May, and June. The next Winter Course will begin on Monday, October 3rd.

UNIVERSITY COLLEGE.

FACULTY OF SCIENCE.

Professor.—William Ramsay, Ph.D.

Assistant Professor.—R. T. Plimpton, Ph.D.

Assistants.—S. Rideal, D.Sc., F.C.S., N. Collie, Ph.D.

The Session is divided into three Terms, as follows, all the dates being inclusive:—

First Term, from Wednesday, October 5th, until Saturday, December 17th;

Second Term, from Tuesday, January 10th, 1888, till Saturday, March 24th;

Third Term, for Lectures, from Tuesday, April 17th, till Saturday, June 16th. Class Examinations occupy about ten days, beginning on Monday, June 18th.

Students, who having entered in October do not intend to present themselves in all three subjects at the July Preliminary Science Examination, should during the first term confine their attention to Chemistry, and take this subject alone at the January Examination.

Students entering in January should take Physics and Biology at the July Examination, and Chemistry at the succeeding January Examination.

The Special Course on the Metals will be given by Mr. Rideal on Monday, Wednesday, and Friday, at 10.

Introductory or Matriculation Course.

Tuesday, Wednesday, Thursday, and Friday, at 11, commencing May 4, 1888. Fee:—£4 4s.

The Course will consist of about thirty lessons, partly theoretical and partly practical, on the non-metallic elements. Frequent exercises will be given.

General Course of Chemistry and Chemical Physics.

First and Second Terms: Inorganic.—The Class meets six times a week: Mondays, Wednesdays, and Fridays, at 11, and Saturdays, at 9, for Lectures or Examinations; and on Tuesdays and Thursdays, at 9, for Exercises.

Third Term: Elementary Organic.—Lectures or Exercises, Tuesdays, Wednesdays, and Fridays, at 11.

Fee:—For the Course, £7 7s.; Perpetual, £9 9s.; for the First or Second Terms, £4 4s.; for the Third Term, £2 2s.

The subjects treated in the First Term of the Course include those required in Chemistry at the Matriculation Examination of the University of London.

For the Preliminary Scientific Examination Students who take the three subjects for that examination in July attend during the First and Second Terms.

Extra Meetings of the Exercise Class in connection with the General Course will be held in the Third Term for those Students who intend to present themselves for the Preliminary Scientific or Intermediate Science Examination in July.

Organic Chemistry.

Tuesday and Thursday at 11, Saturday at 9, in the First Term; Monday, Wednesday, and Friday, at 9, in the Second Term; and Tuesday and Thursday, at 9, in the Third Term, beginning Wednesday, October 6th. The hour of meeting will be altered should the Class desire it.

This Course of Organic Chemistry is intended for those who in studying the subject have not a Medical Examination chiefly in view. Candidates for Honours at the Int.M.B. are, however, recommended to attend this Course during the First and Second Terms, instead of the Special Summer Course.

The Course includes the subjects required at the B.Sc. Examination, Pass and Honours; but no previous acquaintance with Organic Chemistry will be expected of those joining the Class.

Fee:—For the Course, £6 6s.; for a Term, £2 12s. 6d.

Practical Class.

First and Second Terms, on Tuesday and Thursday, at 11 or 10. Each Student will attend twice a week, at the hour allotted to him, on arrangement with the Professor.

Fee, including cost of materials, £5 5s.; for a Second Course, £3 3s.

The Course includes the Practical Chemistry required at the Preliminary Scientific, Intermediate B.Sc., and Conjoint Scheme Examinations.

Senior Practical Class.

Mondays and Saturdays from 10 to 12 during the Third Term.

Fee:—(Including cost of materials) £5 5s.; for a Second Course, £3 3s.

Matriculation Course. (Women.)

Lectures: Wednesday and Friday, from 4 to 5.

A Class of Elementary Chemistry, including the subjects required for Matriculation, will be given during the Second and Third Terms, commencing Wednesday, January 11th.

Fee:—For the Course, including the cost of apparatus and materials, £4 4s.; for the Third Term, £2 12s. 6d.

Inorganic Chemistry. (Women).

Lectures and Practical Work: Wednesday at 3, Thursday at 12, Friday at 11, Saturday at 10, during the First and Second Terms, beginning on Wednesday, October 6th. The time of meeting will be altered to suit the convenience of the Class.

This Class includes the subjects required for the Preliminary Scientific and Intermediate B.Sc. Examinations. An elementary knowledge of Chemistry will be expected from students joining the class. Simple Qualitative Analysis will be practised by the Students.

Fee, including cost of apparatus and materials, £7 7s.; for one Term, £4 4s.

Analytical and Practical Chemistry.

The Laboratory is open daily from 9 a.m. to 4 p.m., Saturdays excepted, from October until the middle of July, with a short recess at Christmas and at Easter.

Fees: for the Session, £26 5s.; six months, £18 18s.; three months, £10 10s.; one month, £4 4s.

Three specified days a week:—for the Session, £15 15s.; six months, £11 11s.; three months, £6 6s.; one month, £2 12s. 6d., exclusive of expense of materials. Students may enter at any period of the Session.

The Laboratory Course includes the Practical Chemistry required at the following Examinations of the University of London:—Prel. Sci. (M.B.), Intermediate M.B., Intermediate B.Sc., B.Sc.

Students who wish to attend the Laboratory and Classes of Technical Chemistry may acquire here the requisite preliminary knowledge of Practical Chemistry and Analysis.

When accompanied by, or preceded by, attendance on the Lectures on Chemistry and Organic Chemistry, the Laboratory Course qualifies Students in the application of Chemistry to Manufactures, Metallurgy, Medicine, or Agriculture, &c.

There is also a Chemical Library containing the chief Journals and Standard Works on Chemistry.

A Gold Medal and Certificates of Honour are competed for by Students entered for the Session.

Chemical Technology.

Professor Charles Graham, D.Sc., F.I.C.

Assistants.—C. J. Wilson, F.C.S., and W. J. Scrutton.

The Course of instruction in this Department is designed to afford to Students who propose to devote themselves to industrial pursuits in which Chemistry plays an important part, or to prepare themselves for the profession of Consulting Chemist, the instruction essential for their success in their future line of work. It will also be found of great value in two of the branches (Organic and Inorganic Chemistry) in which the Degree of Doctor of Science can be taken at the University of London.

In the Session 1887-88, it is proposed to treat of the following subjects:—

Heating and Lighting.
Metallurgy.
The Chemistry of the Alkali trade.
Agricultural Chemistry.

Fees—for each Course, £2 2s.; for two Courses, £3 3s. for the four Courses, £5 5s.

Courses of Lectures will also be delivered on the Chemistry of Brewing (fee, £3 3s.), and on Chemistry in its relation to Engineering and Architecture (fee £2 2s.).

Laboratory of Chemical Technology.

The instruction in the Laboratory of Chemical Technology will consist of the examination and valuation of raw materials used, and of the final products obtained in various manufacturing industries, and of experimental examination of the processes employed in the arts and manufactures.

The Laboratories are open daily from 9 a.m. to 4 p.m., from the 6th of October until the middle of July, with a short recess at Christmas and at Easter.

Fees—for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

Residence for Students.

Students can obtain residence at University Hall, Gordon Square. Particulars can be obtained at the office of the College.

NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOL OF MINES.

Professor.—T. E. Thorpe, Ph.D., B.Sc., F.R.S.

Assistant Professor.—F. R. Japp, M.A., Ph.D., F.R.S.

Demonstrators.—W. R. Hodgkinson, Ph.D., and P. F. Frankland, Ph.D., B.Sc.

Assistants.—G. S. Newth, H. Chapman Jones, and Dr. Gibson Dyson.

The Normal School of Science at South Kensington is intended, primarily, for the instruction of teachers, and of students of the industrial classes selected by competition in the examinations of the Science and Art Department. The Royal School of Mines is affiliated to the Normal School. Students entering for the Associateship of the School of Mines obtain their general scientific training in the Normal School. The instruction in the Normal School is arranged in such a manner as to give the Students a thorough training in the general principles of Science, followed by advanced instruction in one or more special branches of Science. The Associateship is granted in certain divisions or lines of study. Students who go through any one of the prescribed courses of instruction and pass the necessary Examinations receive a Certificate of Associateship of the Normal School, or of the Royal School of Mines. But students who are not candidates for the Associateship are permitted to take up the course of instruction in one or more special branches of science, and on passing the examination receive a Certificate to that effect. The Associateship of the Normal School of Science is given in one or more of the following divisions:—Mechanics, Physics, Chemistry, Biology, Geology, and Agriculture, and the Associateship of the Royal School of Mines in Metallurgy and Mining.

The course of instruction, which lasts for three years, is the same for all the divisions during the first year, after which it is specialised in accordance with the Scheme detailed in the Prospectus of the School.

The Session is divided into two Terms. The first Term begins about the 4th of October and ends about the middle of February. The second Term begins in the middle of February and ends about the middle of June.

Examinations are held at the end of each course of instruction and at such other periods as may be found necessary. On the results of these examinations the successful candidates are arranged in two classes, first and second. There are also "Honours" examinations for the subjects of the third year, the successful candidate being placed in order of merit. A student obtains the Associateship who passes in all the subjects of the first two years and of the special division he selects for his Associateship. A student who goes through the prescribed course of instruction in any subject and passes the final examination in it receives a certificate to that effect.

Students who do not wish to attend the lectures are admitted for short periods to the laboratories, at the discretion of the Professors. The fees for the laboratories are £4 per month.

Students not entering for the Associateship are admitted to any particular course of study, so far as there is room, on payment of the fees shown in the following table, which must be paid to the Registrar of the School before the commencement of each course.

	Part I. Lecs. & Lab.	Part II. Lecs. & Lab.	Part III. Lecs. & Lab.	Part IV. Lecs. & Lab.
	£	£	£	£
Chemistry	3 13	16	16	
Physics	5 12	12	12	
Biology with Botany	5 12			
Geology with Mineralogy ..	4 8	8	8	
Mechanics	4 6	8	8	
Metallurgy	2 13	15		
Mining	4 6			
Agriculture	4 10			
Astronomy	2			

Mathematics and Mechanical Drawing £3 per term. Geometrical Drawing, £3 per session. Freehand Drawing, £1 per term.

Thus the fees for the first two years amount to about £75, and for the remainder of the course for the Associateship they vary from £30 to about £40.

Both the private and the State-aided students are required to furnish themselves with certain instruments and apparatus before the commencement of the courses. These are enumerated in the syllabuses of the several subjects.

Officers of the Army, Navy, and Civil Service, recommended by their respective Departments, are admitted to the Lectures and Laboratories at half the foregoing charges.

Associates of the Normal School of Science or of the Royal School of Mines have the privilege of free admission to the Library and to all the courses of lectures.

Science teachers actually engaged in teaching who are registered by the Science and Art Department as qualified to earn payments for teaching Science may attend any course of lectures on the payment of £1.

Several valuable Exhibitions, Scholarships, and Prizes are attached to the studentship.

Summer Courses for Teachers.—Short courses of instruction are given annually, about July, in different branches of science for the benefit of teachers of science schools in the country. The courses last three weeks. About 200 teachers are admitted to them, and they receive 2nd class railway fare to and from South Kensington, and a bonus towards their incidental expenses of £2 each. (See Science Directory.)

Working Men's Lectures.—Three courses of evening lectures for working men will be given during the session in Chemistry, Physics, and Mineralogy. The admission to each course of six lectures will be 6d. The number of tickets is limited by the size of the lecture theatre.

UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH.

Professor of Chemistry and Experimental Physics.—T. S. Humpidge, Ph.D., B.Sc. (Lond.)

The College is open to male and female students not under the age of 15 years. The Session begins on Tuesday, September 20.

The Courses will be as follows.— I. Introductory and Chemistry of the Non-Metals, during Michaelmas Term. II. Chemistry of the Metals and Chemical Theory, during Lent Term. III. Organic Chemistry and Advanced Theoretical Chemistry, during Easter Term.

Course I. will suffice for the requirements of the London University Matriculation and other similar examinations. Candidates for the Intermediate B.Sc. and Preliminary Scientific (M.B.) Examinations will require Course II. as well, and must also take a course of practical instruction in the Chemical Laboratory. Course III. will meet the requirements of Students taking Chemistry in the B.Sc. and other advanced examinations.

In connection with Courses I. and II. there will be Exercise Classes meeting once a week.

The Lectures will be delivered and the Exercise Classes will meet on Tuesdays, Wednesdays, Thursdays, and Fridays at 10 a.m.

The Fee for the whole Session, paid in advance, is £10; if paid by single Terms, for the first Term of attendance in each Session £4; for the second Term, £3 10s.; for the third Term £3. Any person wishing to attend single classes may do so on payment of the sum of £1 per Term for each class.

Practical Chemistry.—The Laboratory is open to Students daily during the Session from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except Saturdays.

Special courses will be arranged for those Students who intend following Medicine, Pharmacy, Agriculture, Applied Chemistry, or other professions in which a knowledge of technical chemistry is required.

Several valuable Scholarships and Exhibitions are attached to the Studentship.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE.

Professor.—C. M. Thompson, M.A., D.Sc., F.C.S.
Demonstrator.—J. W. James, Ph.D., F.C.S.

The Session commences October 4th, and terminates in June, and is divided into three terms.

The Junior Course (delivered during the Michaelmas term only) consists of about 55 lectures, and will cover the subjects prescribed for the London University Matriculation examination. Fee, £2 2s.

The Intermediate Course consists of 90 lectures in continuation of the Junior Series, and, together with laboratory practice, will cover the subjects required for the Intermediate Examination in Science and the Prel. Sci. (M.B.) Examination of the University of London. Fee £3 3s.

The Senior Course includes some 90 lectures devoted to Organic Chemistry; Fee, £3 3s.

A course of 30 lectures on Qualitative and Quantitative Analysis and Chemical Calculations. £1 1s.

The Laboratory Course may be modified to meet the requirements of individual students wishing to obtain a special knowledge in some branch of manufacturing or industrial chemistry. Hours, 9 to 1 and 2 to 4.30; Saturday, 9 to 1. Fees—Six hours per week, £3 3s. per session; twelve hours, £2 2s. per term; eighteen hours, £3 3s. per term; twenty-four hours, £4 4s. per term.

Evening Lectures.—A course of Lectures will be given on Elementary Chemistry. Courses of lectures on Chemistry and the Iron and Steel Manufacture will also be delivered in certain towns in South Wales in connection with the local lecture scheme.

At the entrance examination in September, and the annual examination in June, several scholarships, &c., are awarded.

A Hall of Residence for Female Students is attached to the University, and new Chemical, Physical, &c., Laboratories will be opened by Sir William Grove in October.

UNIVERSITY COLLEGE, BRISTOL.

Professor of Chemistry.—Sydney Young, B.Sc.

Lecturer.—Arthur Richardson, Ph.D.

The session 1887—88 will begin on October 4. Lectures and classes are held every day and evening throughout the Session. In the Chemical Department lectures and classes are given in all branches of theoretical chemistry, and instruction in practical chemistry is given daily in the chemical laboratory. Excursions to some of the mines, manufactories, and chemical works of the neighbourhood are occasionally made. The department of experimental physics includes various courses of lectures arranged progressively, and practical instruction is given in the physical and electrical laboratory. The Department of Engineering and the Constructive Professions is designed to afford a thorough scientific education to students intending to become engineers, or to enter any of the allied professions, and to supplement the ordinary professional training by systematic technical teaching. This department includes courses specially arranged for students intending to become civil, mechanical, electrical, or mining engineers, surveyors, or architects. Those who attend the mechanical engineering course enter engineering works during the six summer months, and, in accordance with this scheme, various manufacturing engineers in the neighbourhood have consented to receive students of the College into their offices and workshops as articled pupils. Medical education is provided by the Bristol Medical School, which is affiliated to the College. Several Scholarships are tenable at the College.

DAY LECTURES.

Inorganic Chemistry.

The Course treats of the principles of Chemistry, and of the Chemistry of the Non-Metals and Metals.

Lectures will be given daily at 9 o'clock.

Organic Chemistry.

This Course will relate to the more important groups of the Compounds of Carbon.

Lectures will be given during the Second Term on Tuesdays and Thursdays at 10 o'clock; during the Third Term on Tuesdays, Thursdays, and Saturdays at 10 o'clock.

Fee, £3 3s.

Practical Chemistry.—Laboratory Instruction.

The Laboratory will be open daily from 10 a.m. to 5 p.m., except on Saturdays, when it will close at 1 p.m. Instruction will be given in the Laboratory in all branches of Practical Chemistry, including Qualitative and Quantitative Inorganic and Organic Analysis, the preparation of Chemical Products, and Inorganic and Organic Research. Special facilities will be afforded to those who desire to study Practical Chemistry as applied to the different processes employed in the Arts and Manufactures, and to Scouring, Bleaching, and Dyeing. The Laboratory is under the immediate supervision of the Professor and the Lecturer.

Fees in Guineas—

	6 Days a Week.	5 Days a Week.	4 Days a Week.	3 Days a Week.	2 Days a Week.
Per Session	17	15	13	10	7½
,, Two Terms ..	13	11	9	7½	5½
,, One Term ..	7	6	5	4	3
,, Month	3	3	2	2	1½

Students may arrange to divide their days of laboratory work into half-days.

Photographic Chemistry.

A Course of Lectures will be given by Mr. A. Richardson, Ph.D., on Mondays at 10, which will cover the subject as prescribed for the Technological Examination of the City and Guilds of London Institute; fee, £1 1s. for each term. The Photographic Laboratory is open from 10 to 5 every Wednesday; fee, £3 3s. for each term. A Course of Evening Lectures on the same subject will also be given on Fridays at 7.

EVENING LECTURES.

Lecturer.—Sydney Young, B.Sc.

Wednesday and Friday, 8 to 9.

This course will consist of Two Lectures a week during the First and Second Terms; they will be devoted to the consideration of the general Principles of Chemistry and Chemical Physics and the Chemistry of Non-Metallic Elements. Special attention will be paid throughout to those products which have a practical application in the Arts and Manufactures.

Fee, 15s. for Two Terms; 10s. for One Term.

A Course of Lectures will also be delivered on Monday evenings at 8, on the Chemistry of Every-day Life.

Chemical Scholarship.—Among others, a Chemical Scholarship of £25 is offered for competition.

With the approval of the Council of the Institute of Chemistry students desiring to qualify as Associates may pass through the requisite amount of study at this College, which has also been approved as a centre for the Practical Examination of the Institute.

MASON SCIENCE COLLEGE, BIRMINGHAM.

Professor.—W. A. Tilden, D.Sc., Lond., F.R.S.

Assistant Lecturer.—W. W. J. Nicol, M.A., D.Sc., Edin.

Demonstrator.—Thomas Turner, F.C.S.

The Session will be opened on Monday, October 3rd, 1887.

Elementary Course.

Forty Lectures adapted to the requirements of beginners will be given in the Winter and Spring Terms. A Second Course of Twenty Lectures, having reference only to the subjects included in the syllabus of the Matriculation Examination of the University of London, will be given in the Summer Term. Lecture days—Wednesdays and Fridays at 11.30, Thursdays at 4.30.

Persons entirely unacquainted with Chemistry are recommended to attend the first of these Courses before entering for the General Course, which commences in October. Candidates for the Matriculation Examination of the University of London are advised to attend both these Courses.

General Course.

The General Course of Lectures on Chemistry will be found useful by Students who are afterwards to become

Engineers, Architects, Builders, Brewers, or Manufacturers (such as Metallurgists, Alkali, Soap, Manure, Glass, or Cement Makers, Bleachers and Dyers, &c.)

Students preparing for the Intermediate Examination in Science and Preliminary Scientific (M.B.) Examination of the University of London should attend the Lectures on *Inorganic Chemistry* (Winter and Spring Terms).

Candidates for B.Sc. and Intermediate Examinations in Medicine will in general require only that part of the course (Spring and Summer Term) which relates to *Organic Chemistry*.

The full course, extending over three terms, will also satisfy the requirements of Students preparing for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

1. From October to March (Winter and Spring Terms). About one hundred lectures on *Inorganic Chemistry and Chemical Philosophy* will be given on Mondays, Tuesdays, Wednesdays, Thursdays, and Fridays, at 9.30 a.m. Fee, £3 3s. for a single term, or £5 5s. for the course from October to March.

2. April to June (Summer Term). About forty lectures will be given on *Organic Chemistry*, or the chemistry of the most important series of carbon compounds. This course will include all the subjects required for the Intermediate Examination in Medicine of the University of London. Lecture Days—Monday, Tuesday, Wednesday, and Thursday, at 9.30 a.m. Fee, £2 2s.

In all these courses the instruction will often take the form of class teaching, and exercises will be set which students will be expected to work at home.

Laboratory Practice.

The College Laboratory will be open daily from 9.30 to 5, except on Saturdays, when it will be closed at 1 p.m.

Candidates for Intermediate Examination in Science, Preliminary Scientific (M.B.), B.Sc., and Intermediate Examination in Medicine of the University of London, may obtain in the Laboratory of the College the instruction necessary. The three months Course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health, may be taken in the Mason College Laboratory.

The Ordinary Course for Medical Students is given on Tuesdays and Thursdays from 2 to 4 p.m. throughout the Summer Term.

Fees:—

	All day.	Three hours per day.
One Term	7 guineas	.. .. 4½ guineas.
Two Terms	13 „	.. .. 8½ „
Threee Terms	18 „	.. .. 12 „

A Course of short demonstrations and exercises will be given by the Professor or one of his Assistants once a week. All first-year Students will be required to attend, unless exempted for special reasons by the Professor. No Fee.

Metallurgy.—A Course of Twenty Lectures will be given in the Winter Term (October to Christmas), on Tuesday and Friday Afternoons at 2.30, on the Principles and Practice of Metallurgy. Fee, £1 1s. After Christmas a Course of Lectures will be given on Iron and Steel.

Arrangements have been made in the Chemical Laboratory for giving instruction in Practical Metallurgy.

Evening Classes.

A Course of Lectures on the Chemistry of Illuminants, by Professor Tilden, and on the Chemistry of Common Life, by Dr. Nicol, will be given during the Winter and Spring Terms, on Tuesdays and Fridays at 8. Fee, 5s. each.

Excursions.

During previous Sessions permission has been obtained to visit some of the great factories in or near Birmingham, in which chemical and metallurgical industries are carried on. Students have thus had most valuable opportunities of gaining a practical acquaintance with some branches of Applied Science. The privilege thus courteously granted by several manufacturers will, it is hoped, be enjoyed in every future Session. The excursions will be conducted by the Professor.

ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.

Chemical Department.

Professor.—Prof. E. Kinch, F.C.S., F.I.C.

Systematic courses of Lectures are given on the various branches of Chemistry in its relation to Agriculture, illustrated by experiments, and by the collections in the College Museum. They comprise the laws of Chemical Combination and the general Chemistry of mineral bodies, and of the more frequently occurring bodies of organic origin, with the relationships of their leading groups; and, finally, the applications to practical operations of the Chemistry of the atmosphere, of soils and manures, of vegetation and stock feeding, and of the processes and products of the dairy.

In the Laboratory practical instruction is given in the construction and use of apparatus and in Chemical manipulation and analysis, both qualitative and quantitative. After studying the simple operations and the properties of the commonly occurring substances, the Students are taught to analyse a series of compounds, and apply the knowledge thus obtained to the analysis of manures, soils, waters, feeding stuffs, dairy products, and other substances met with in the ordinary course of Agricultural practice. Chemico-agricultural researches are undertaken by the senior Students under the direction of the Professor and his Assistants.

THE YORKSHIRE COLLEGE, LEEDS.

Professor of Chemistry.—Arthur Smithells, B.Sc. Lond., F.C.S.

Assistant Lecturers.—C. H. Bothamley, F.C.S., and Herbert Ingle.

The Session begins October 3, 1887.

Lecture Courses.

1. General Course on Systematic Chemistry—Monday, Tuesday, Thursday, and Friday, at 4 p.m., from October to the end of the second term. Fee for the Course, £5 5s.

2. Organic Chemistry—Tuesday and Thursday at 12.30 p.m., during the Second and Third Terms. Fee £2 12s. 6d.

3. Theoretical Chemistry — Advanced Course. Fee, £1 11s. 6d.

4. Lectures on Chemical Technology—Will be varied from session to session. During Session 1887-8 a Course of Lectures "On Fuel" will be given on Wednesdays, at 4 p.m., during the Second and Third Terms. Fee £2 2s.

5. Chemistry as Applied to Coal Mining—Wednesday, during the First Term, at 5.30 p.m.

6. Lectures on Laboratory Practice and Chemical Calculations—Monday, at 12.30 during the First and Second Terms. Fee, £1 1s.

7. A Class on Elementary Chemistry, consisting of about Twenty-five Lectures, on the Non-metals, will be held on Saturdays, at 12.30 p.m. Fee for the Lecture Class, 10s. 6d.

8. Photographic Manipulation—A Course of Ten Lessons will be given on Fridays, from 2 to 5, during the Third Term, with special reference to dry plate processes and silver and platinum printing. Fee, £1.

Laboratory Courses.

The College Laboratory will be open daily from 9 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it will close at 1 p.m.

Fees for the Session—Students working six days per week, £18 18s.; five, £16 16s.; four, £14 14s.; three, £12 12s.

Class in Practical Chemistry, Saturday mornings, from 9.30 to 12.30. Fee £1 11s. 6d.

Practical Chemistry for Medical Students.—On Tuesday and Thursday, from 10 to 12 a.m., from May to July.

Evening Classes.

A Course of twenty Lectures by Mr. C. H. Bothamley, on the Elements of Inorganic Chemistry (the Non-Metals) will begin during the first and second Terms, on Wednesdays, at 7.30 p.m., beginning October 12. Fee, 10s. 6d.

Dyeing Department.

Professor.—J. J. Hummel, F.C.S.

This Course extends over a period of three years, and is intended for those who wish to obtain a full scientific and practical education in the art of dyeing. It is suitable for those who purpose in the future to take any part in the direction of the operations of dyeing or printing of textile fabrics, *e.g.*, the sons of manufacturers, calico printers, managers, master dyers, &c.

Several valuable Scholarships are at the disposal of the College, viz., the Cavendish, Salt, Akroyd, Brown, and Clothworkers' Scholarships, and the Leighton Trustees' Exhibition.

UNIVERSITY COLLEGE, LIVERPOOL.

Professor.—J. Campbell Brown, D.Sc.

Demonstrators.—C. A. Kohn, B.Sc., Ph.D., S. G. Rawson, B.Sc.

Assistant.—James B. Spurge.

The new Chemical Laboratories, which were opened in May, 1886, provide accommodation for every kind of chemical work. Besides the Chemical Lecture Theatre, seating 230, a smaller class room and a Practical Theatre accommodating 52 Students in Elementary Practical Chemistry and Qualitative Analysis, ample accommodation is provided for about 40 more advanced Students. An elaborately fitted room is provided for Organic work, which will be used temporarily as a Quantitative Laboratory, while organic operations will be carried on in a second organic room containing arrangements for combustions, operations in sealed tubes, and other special operations. Separate rooms are provided for Water Analysis, Gas Analysis, Photometry and Photography, Spectroscopic and Microscopic work. There is a balance Room, a Furnace Room, besides Stores, Service Rooms, Lavatories, and a separate room for ladies. The teaching is aided, especially in the Organic branch of the science, by a Chemical Museum. A dynamo is provided for experiments in the reduction of metals and other work employing electricity. The courses are intended to instruct the Student in Chemical Manipulation, Qualitative and Quantitative Analysis, Gas, Water, and other special branches of analysis, Organic Synthesis, Spectroscopy, Thermal Chemistry, and in the method of performing Chemical Researches, and making investigations with the view of applying Chemistry to Manufactures, Agriculture, or Hygiene, or to aid in the study of other sciences.

The Session commences October 3rd.

Students desirous of having a thorough theoretical and practical acquaintance with Technical Chemistry, or who intend to adopt Chemistry as a profession, must devote at least three years to special study. They ought to have an ordinary school acquaintance with English Composition and Latin, and must be proficient in Arithmetic and the elements of Algebra.

They are recommended to adopt the following curriculum :—

First Year.—Chemistry—Course of Lectures on Theoretical Chemistry during the Autumn and Lent Terms; Chemical Laboratory, two days a week, during the Lent and Summer Terms; and the Practical Chemistry Class. Mathematics and Mechanics, Physics, Engineering Drawing and Design, French or German.

Second Year.—Chemistry — Second Attendance on portions of the Lecture Courses; Lectures on Organic Chemistry; Chemical Laboratory, two or three days per week, and the Practical Organic Class during the Summer Term; Technological Chemistry. Physics, Mathematics, German or French.

Third Year.—Lectures on Organic Chemistry; Lectures on Chemical Philosophy; Chemical Laboratory, four or five days per week; Technological Chemistry; Physical Laboratory, one day per week; Engineering—Strength of Materials.

The Sheridan Muspratt Chemical Scholarship of £50 per annum, tenable for two years, will be awarded in December on an Examination in subjects which are included in the first two years of the above curriculum. Other Scholarships, Entrance Scholarships, and Free Studentships are also available to Students.

The Laboratory is opened for Students from 10 a.m. to to 5 p.m. daily, on Saturdays from 10 to 1 only.

The Prospectus containing full particulars may be obtained from Adam Holden, 48, Church St., Liverpool, price 6d.; or from the Registrar, University College, Liverpool.

LIVERPOOL COLLEGE OF CHEMISTRY.

Principal.—George Tate, Ph.D., F.G.S., F.C.S.

The Laboratories are open daily from 10 to 5, excepting Saturdays, when they close at 1 p.m. The course of instruction is adapted to the requirements of students of Chemistry as a science, and in its applications to chemical and metallurgical industries. The fee for a three years' course of study is eighty-five guineas, or per session of three months ten guineas.

Prospectuses, containing full particulars of the day and evening classes, may be had on application at the College.

UNIVERSITY OF DURHAM.
COLLEGE OF PHYSICAL SCIENCE, NEWCASTLE.

Professor of Chemistry.—P. Phillips Bedson, D.Sc., F.C.S.

Demonstrator—Saville Shaw.

The Session will commence on September 26th, 1887.

Junior Division: First Year Course.—This Course of Lectures will extend over the three terms of the Session, and is intended to serve as an introduction to the Science. The Lectures will be of an elementary character, and whilst framed to meet the requirements of First Year Students will also be serviceable to such as intend pursuing Chemistry in its various applications in the arts and manufactures, as, for instance, Brewing, Metallurgy, the Manufacture of Soda, Soap, Glass, &c. The subjects treated will include an exposition of the Principles of Chemistry, and a description of the preparation and properties of the chief Elementary Substances, both metallic and non-metallic, and their more important native and artificial compounds. The class will meet on Mondays, Wednesdays, and Fridays, at 9.30 a.m., and will commence on Wednesday, October 5th.

Senior Division: Second Year Course.—A Course of about sixty Lectures will be given throughout the Session, the subject of which will be Organic Chemistry, or the Chemistry of the Carbon Compounds. This class will meet on Tuesdays and Thursdays, at 12, and will commence on Tuesday, October 4th.

Fee, for either Course, five guineas for the Session.

A Special Course will be given on Applied Chemistry, commencing Thursday, October 6th. Fee, £2 2s.

Practical Chemistry.—The Laboratory is open from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it closes at 1 p.m. *Laboratory Fees.*—Students working six days per week, £5 5s. per term; alternate days, £3 3s.; one day per week, £1 1s.

Courses of Study.—Students will be divided into two classes :—(1) Regular, or Matriculated Students; and (2) Non-Matriculated Students. Regular Students will be required to follow such a course of study in the subjects professed in the College as will enable them to pass the Examinations for the title of Associate in Physical Science. Non-Matriculated Students will attend such classes as they may select. Every candidate for admission as a matriculated student must pass

an examination on entrance, in reading, writing from dictation, English or Latin Grammar, arithmetic (including decimals), and geography. Registered students in medicine are exempted from this examination, or students who produce a certificate of having passed either of the two following examinations:—

1. Durham Examination for certificate of proficiency in General Education, held in March and September.

2. Durham Examination for Students in Arts in their first year, or any examination of a similar nature that may be accepted by the Council.

Associateship in Physical Science.—Every candidate for the Associateship in Physical Science will be required to satisfy the examiners in three, at least, of the four subjects,—Mathematics, Physics, Chemistry, and Geology,—in an examination, to be held at the beginning of his second year.

Exhibitions.—Three Exhibitions of the value of £25, £15, and £10 respectively will be awarded in October next to Candidates desirous of attending the first year course of study in the College.

Candidates must send their names to the Secretary, on or before the 17th of September, and specify, at the same time, the special subject in which they desire to be examined.

The examination will be held at the College, and will commence on Monday, September 26th.

Two Exhibitions of £15 each will be awarded at the next examination of "Persons not members of the University," which will be held at Durham in March next.

Several other valuable Scholarships are available for students.

OWENS COLLEGE, VICTORIA UNIVERSITY, MANCHESTER.

Professor and Director of the Chemical Laboratory.—Harold B. Dixon, M.A., F.R.S.

Professor of Organic Chemistry.—C. Schorlemmer, F.R.S.

Lecturer on Technological Chemistry.—Watson Smith, F.C.S., F.I.C.

Demonstrators and Assistant Lecturers.—Watson Smith, F.C.S., Harry Baker, F.C.S., Julius B. Cohen, Ph.D., and George H. Bailey, D.Sc.

The Session begins on October 4, 1887, and ends on June 22, 1888.

The instruction is given by means of Experimental Lectures and Tutorial Classes. The Chemical Classes form part of the Courses for Chemistry in the University.

Technological Chemistry.

Persons desiring to attend this course will be required to enter the College under the ordinary conditions of studentship.

The object of this course is to offer to students intending to devote themselves more especially to Applied Chemistry as complete a training as the College can provide in those branches of instruction which form the scientific foundation of the subject.

The complete course of instruction extends over four years, and embraces the following subjects:—

First Year.—Chemistry Lectures, General Course. Preparatory:—Chemical Laboratory, two days per week. Pure Mathematics. Elementary Mechanics. Geology. French or German. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Second Year.—Chemistry Lectures, Junior and Senior classes. Chemical Laboratory, three days per week. Technological Chemistry Lectures. Elementary Physics or Mineralogy Lectures and Practical Courses. German or French. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Third Year.—Chemistry Lectures, Senior classes. Organic Chemistry Lectures. Chemical Philosophy. Chemical Laboratory, three days per week. Technological Chemistry Lectures (second course). Physical Laboratory, 1 day per week, or Advanced Mineralogy Lectures and Practical Course. Mechanical Drawing, Practical (evening class).

Fourth Year.—Organic Chemistry Lectures.* Technological Chemistry Lectures (third year's course). Chemical Laboratory, 4 days per week. Mechanical Drawing, Practical (evening class).

Fees.—Every student is required to pay on admission an entrance fee of £1 1s. and a library fee of 5s., and the fees for the classes for which he enters. As alternative courses are in some instances open to a student offering himself for the Victoria University Examinations, it is not practicable to give tabular statements of the fees for every combination of classes. Special prospectuses may be obtained at the office of the College.

Certificates will be granted to students on the successful completion of this course. Attendance on the full course of four years is expected of candidates for the Certificate, but students may obtain exemption (on cause shown) from the first or the first and second year's courses. Students so excused will nevertheless be required to undergo examination in all the subjects specified. The Certificate will state in which subjects the candidate has gained Honours, and in which he has merely satisfied the Examiners.

An ordinary degree of B.Sc. in Chemistry may be taken at the College in either two or three years, according as to whether the student passes the Preliminary Examination on joining the College or whether he takes a year to prepare for that examination. The Degree of B.Sc. with Honours in Chemistry can be taken in three years, and the College Certificate in Technological Chemistry may be taken in the same time.

A number of important Exhibitions, &c., are available to students.

UNIVERSITY COLLEGE, NOTTINGHAM.

Professor of Chemistry—Frank Clowes, D.Sc. Lond., F.I.C., F.C.S.

Demonstrator—Mr. J. B. Coleman, F.C.S.

Lecturer on Dyeing and Metallurgy.—Mr. R. L. Whiteley, F.C.S.

The Classes of the College are open to students of both sexes above sixteen years of age. In virtue of the affiliation of the College to Cambridge University a suitable course of study is recognised in lieu of part of the ordinary residence at Cambridge for those intending to take degrees at that University. Reference should be made to the College Prospectus for fuller information.

The dates of commencement and end of Terms in the Session 1887-8 will be as follows:—First Term, October 3rd to December 17th; Second Term, January 16th to March 29; Third Term, April 16th to July 1st.

Lecture Courses.—The Chemistry Day Lectures extend over three years. In the first year a student enters for the course on Non-Metals for the first two terms and for Elementary Organic Chemistry in the third term. In his second year he takes the course on Metals for the first two terms, and Advanced Organic Chemistry in the third term. In his third year he attends a course on Applied Chemistry during the first two terms.

Fee for Day Lectures and Classes, 50s. for the session of three terms: Non-Metals or Metals 42s.: Organic Chemistry (one term) 21s.: Applied Chemistry, 30s.

Lectures on Analytical Chemistry will be given at 12 o'clock each Wednesday in term time throughout the session, and should be attended by all first year students. A similar course of lectures will be given at 6.30 on Tuesday Evenings.

A Chemical Calculation Class will meet on Friday Evenings at 7.

Fee per term, 2s. 6d.

Students may qualify themselves by attendance at these

* Students who gain a place in the First or Second class in the annual examinations will be excused a second attendance on this class.

lectures and classes for the Examinations of the Universities of London, Cambridge, or Oxford: they may also obtain instruction in Chemistry for technical or other purposes.

Practical Chemistry.—The chemical laboratory is open every day except Saturday from 10 to 1 and from 2.30 to 5.30, also on Tuesday and Thursday evenings from 7 to 9. Each Student works independently of other Students at a course recommended by the Professor. Instruction is given in general Chemical Manipulation and in Qualitative and Quantitative Analysis; and students are enabled to work out the applications of Chemistry to Pharmacy, Dyeing, Agriculture, Brewing, Iron and Steel, Tanning, and other Manufacturing Processes.

Fees.—For one term, £6; for the session, £15; for day students for six hours weekly 40s., and 5s. extra for each additional hour per week; for evening students 10s. for one evening per week, and 20s. for two evenings per week.

Courses of Lectures are also given on Pharmaceutical Chemistry and Materia Medica, and on the Chemistry of Dyeing and Bleaching.

Government Lectures and Classes.—Evening Lectures and Laboratory instruction will be given by the Demonrator of Chemistry to Students who intend to present themselves for Examination by the Government Science and Art Department in May next. Inorganic, organic, and practical chemistry will be taught in the elementary and advanced stages, each of which commences at the beginning of the College Session in October. Fees for each Lecture Course, 2s. 6d.; for each Laboratory Course, 7s. 6d. Students joining these classes are expected to become candidates for the Government Examinations in May.

FIRTH COLLEGE, SHEFFIELD.

Professor of Chemistry.—W. Carleton Williams, B.Sc., F.C.S.

Demonstrator and Assistant Lecturer.—L. T. O'Shea, F.C.S.

The Session will commence on Tuesday, October 4, 1887.

First Year's Course.—Chemistry of the Non-Metallic Elements. Monday, Wednesday, Friday, from 10 to 11 a.m. Fee, £3 13s. 6d.

Second Year's Course.—Chemistry of Metals. Tuesday and Thursday, from 10 to 11 a.m. £2 12s. 6d.; or for the First and Second Courses, £5 5s.

Third Year's Course.—Organic Chemistry, on Wednesday, from 9 to 10, and Saturday, from 10 to 11. Fee, £2 2s.; Second and Third Courses together, £4 4s.

A Course of Lectures is arranged for Medical Students, with a special class in Qualitative Analysis.

Laboratory.—Working hours to be arranged between Professor and Students.

Sessional Fees for Day Students:—Six hours per week, £5 5s.; Nine, £7; Twelve, £8 8s.; Eighteen, £11 5s.: Twenty-four, £14; Thirty-two, £17.

Day Students may not enter for less than six hours a week. Students joining the Laboratory at Christmas will be charged two-thirds and at Easter one-third of the Fees for the whole Session.

Fees for short periods (working thirty-two hours per week):—For one month, £3 3s.; two months, £5 5s.

An arrangement has been entered into with the Science and Art Department, South Kensington, which will enable Science Teachers to work in the Chemical Laboratory for twelve hours a week on payment of one-quarter of the usual fee, the Department being willing to pay the remainder under certain conditions, of which full information may be obtained on application to the Registrar.

Evening Classes.—Lectures, Monday, 8 to 9. Laboratory instruction, Monday and Wednesday, 6 to 9. Sessional Fee, one evening per week, £1 10s.; two, £3; or Lecture Class and Laboratory, on Monday evening, £1 10s.

UNIVERSITY COLLEGE, DUNDEE.

Professor.—T. Carnelley, D.Sc., F.C.S.

Lecture Assistant.—Andrew Thomson, M.A., D.Sc.

The fifth session of the College will be opened on October 10th, 1887.

The Lectures and Laboratory practice in Chemistry are recognised by the Royal College of Physicians and Royal College of Surgeons, London, and by the Royal College of Surgeons, Edinburgh, and for degrees in Science and Medicine by the University of St. Andrews and Edinburgh.

The courses are suitable for the Degrees of the London University and for the Civil Service appointments, and will also satisfy the requirements of students in Pharmacy, and of students who intend to become candidates for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

Lecture Courses.

The object of these courses will be (1) to give systematic instruction in the general principles of the science, and information regarding the elements and their more important compounds; (2) to show how this knowledge may be usefully applied in the Arts and Manufactures.

A course of instruction in Practical Chemistry in the Laboratory is recommended to all who wish to obtain a sound knowledge of the science, and the methods of applying it to useful purposes—the duration of such course depending upon the special wants of the student.—The Professor will be glad to give any information to intending students.

First year's lecture course: Monday, Wednesday, and Friday, from 10 to 11 a.m.; fee, £2 2s.

Second year's lecture course: Tuesday, Thursday, and Saturday, from 9 to 10 a.m.; fee, £2 2s.

Practical Chemistry (Laboratory).

The aim of the Laboratory Courses is to make the student practically acquainted with the science, so that he may conduct chemical analysis and original research, and generally to fit him for applying the science to the Arts, Manufactures, and Agriculture. The courses are also suitable for students preparing for their medical and pharmaceutical examinations. A three months' course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health, may be taken in the College Laboratory.

The Laboratory will be open for students daily from 9 a.m. to 4 p.m., except on Saturdays, when it will be closed at 3 p.m. Each student on entering will be allowed to arrange his working hours to suit his own convenience, but will be required to keep the hours when once fixed.

Sessional Fees for Day Students:—The fees for both sessions are—for six hours per week, £3 3s.; each additional hour per week, 10s. 6d. Day students may not enter for less than six hours a week. Students joining the Laboratory during the second term will be charged two-thirds, and during the third term one-third of the above fees. Students may also enter for short periods, working every day in the week at the following fees:—For one month, £2 12s. 6d.; for two months, £5 5s.; for three months, £7 7s.

Evening Classes.—Courses of Lectures and Practical Laboratory instruction.

UNIVERSITY OF EDINBURGH.

Professor.—A. Crum Brown, F.R.S.E.

The Session will commence on October 18, 1887.

Two degrees in Science are conferred by the University of Edinburgh, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.). Both these degrees are conferred in Physical and Natural Science, in Public Health, and in Engineering.

Candidates for degrees in Physical and Natural Science must pass a preliminary examination in English, Latin,

Arithmetic, the Elements of Mathematics, and the Elements of Mechanics, and in at least two of the following subjects:—Greek, French, German, Higher Mathematics, Natural Philosophy, Logic, and Moral Philosophy.

The First B.Sc. Examination embraces Mathematics, Natural Philosophy, Chemistry, Zoology, including Comparative Anatomy, and Botany. The Second B.Sc. Examination the Higher Mathematics, Experimental Physics, Chemistry, Zoology, Botany, Physiology, and Geology, including Palæontology and Mineralogy.

The D.Sc. Examination embraces Mathematics, Natural Philosophy, Applied Mathematics, Experimental Physics, Practical Astronomy, Chemistry, Zoology and Comparative Anatomy, Animal Physiology, Botany, and Geology, including Palæontology and Mineralogy.

GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE.

The main objects of this College are to afford a suitable education to those who wish to qualify themselves for following any industrial profession or trade, and to train teachers for technical schools. It was founded by an Order in Council, dated 26th November, 1886, according to a scheme famed by the Commissioners appointed under the provisions of the Educational Endowments (Scotland) Act, whereby Anderson's College, the Young Chair of Technical Chemistry in connection with Anderson's College, the College of Science and Arts, Allan's Glen's Institution, and the Atkinson Institution were placed under the management of one governing body.

The Diploma of the College will be awarded to Day Students who have attended the courses of instruction and passed the necessary examinations. The ordinary courses will extend over three years, but arrangements will be made for advanced students continuing their studies in special departments.

The Session opens on Monday, October 3rd, 1887.

The Courses of Lectures, &c., are given at various places as follow:—

Andersonian Buildings, Glasgow.

Professor of Chemistry.—William Dittmar, F.R.S.

Chief Assistant.—Archibald Kling.

Laboratory Assistants.—Frank Lyall, James Robson, and William Cullen.

Junior Assistants.—Andrew Reid and Andrew Hodge.

A Course of Experimental Lectures on Chemistry: Daily from 10 to 11. The Lectures up to the end of the year are devoted to an Elementary Exposition of the Philosophy and the Methods of the Science, as illustrated by the History of the Non-metallic Elements. The rest of the Session is divided between the Chemistry of the Metals and Organic Chemistry, select chapters. In addition to occasional extemporised examinations during class hours, five written examinations are held during the Session, on Saturdays from 10 to 12. Fee, £2 2s.

The Laboratory is open daily (Saturdays excepted) from 10 to 5. Advanced students may obtain permission to work privately on Saturdays also until 1 p.m. The teaching is conducted on the tutorial system, each student working by himself, at a separate place, and on his own subject. Hence students of any grade of advancement may enter at any time, and the course of instruction can be adapted to the special requirements of the individual. Original research is not forgotten, but the Professor makes it a strict rule not to use his students as his private assistants in connection with his own investigations, and rather to discourage original research with students who have not yet obtained a sufficient mastery of all the practically important methods of chemical analysis and of preparative chemistry. Fee per month, £2 2s.; due in advance. For any period of six months or more, if paid in advance, at the rate of £1 15s. per month. The fees include the use of all the ordinary reagents, and of the resources of the laboratory generally; but the student has to find his own small apparatus (test-tubes, beakers, &c.), and also a few of the more expensive reagents—*e.g.*, chloride of platinum, nitrate of silver, molybdate of ammonia.

Supplementary Courses of Lectures and Laboratory Instruction are also given by the Assistants under the superintendence of the Professor.

The "Young" Chair of Technical Chemistry, Young Laboratory Buildings.

Professor.—Edmund J. Mills, D.Sc. (Lond.), F.R.S.

Assistant.—Mr. C. Ellis, F.C.S.

This Chair has for its object the instruction of Students in Chemistry as applied to the various branches of industry in Chemical and other works, Metallurgy, Agriculture, &c.

Lectures.—*Principal Course.*—A Course of Twenty-five Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m., commencing on October 3rd. These Lectures will refer mainly to the application of higher Chemistry, and are more especially intended for manufacturers, inventors, chemical engineers, and senior chemical students. Fee for the Course, One Guinea.

Subsidiary Course.—A subsequent Course of Thirty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m. This Course is more particularly intended for Dyers, Colour Manufacturers, Brewers and Distillers, Tar Rectifiers, Drysalters, and others interested in a knowledge of Technical *Organic* Chemistry. Fee for the Course, £ 1s.

Evening Courses.—There will be a special evening course of twenty-five lectures on Bleaching, Dyeing, and Printing, commencing on October 3rd.

There will be Practical Evening Classes in the following subjects:—Oils, Paints, and Varnishes; Bleaching, Dyeing, and Printing, &c.

Laboratories.—The Laboratories are open daily from 10 to 4, and on Saturday from 10 to 1 o'clock for practical working by the Students, under the superintendence of the Professor and his Assistants.

The Fee for attending the Laboratories is £20 per Session of Nine Months, £14 10s. for Six Months, £7 10s. for Three Months, or £2 10s. per month.

Inventors, Patentees, and others whose investigations require isolation and privacy, as well as professional advice, can have Private Laboratories placed at their disposal. Electric Cable has been laid to these laboratories for the supply, if required, of adequate power.

Science and Art Buildings.

Professor.—A. Humboldt Sexton, F.C.S.

Senior Assistant.—J. Morrow Campbell, B.Sc.

Courses of Day Lectures and Laboratory Instruction in Metallurgy and Mineralogy.

The evening classes in Chemistry, Metallurgy, and Mineralogy commence on Tuesday, October 4th.

Allan Glen's Buildings.

Lecturer.—D. S. Macnair, A.I.C., F.C.S.

UNIVERSITY OF ST. ANDREWS.

United College of St. Leonard and St. Salvator.

Evening Classes and Practical Laboratory Instruction in Inorganic and Organic Chemistry.

Professor of Chemistry. — T. Purdie, B.Sc., Ph.D., Assoc. R.S.M.

The Session begins on November 1st. A Competitive Examination, open to intending Students of Arts or Science, for twenty-five Entrance Bursaries, ranging in value from £39 to £5 each per annum, will be held on Friday and Saturday, October 28th and 29th. Two Degrees in Science are conferred by the University of St. Andrews, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.), the regulations regarding which will be found in the "University Calendar."

Lecture Course.

A Lecture is delivered by the Professor of Chemistry, at 11 o'clock, on five days in the week throughout the

Winter Session. The Course commences with the study of a few typical substances, forming an introduction to the discussion of Chemical Theory; the Non-metallic and Metallic Elements, with their chief compounds, are then considered; and the latter part of the Course is devoted to Elementary Organic Chemistry. Three Lectures weekly are of an elementary character, and are intended to be useful to Students of Arts who desire to study Chemistry as a branch of general education, or with the view of teaching it in schools; the remaining two Lectures weekly constitute a Supplementary Course, framed so as to meet the additional requirements of Candidates for the Degree of Bachelor of Science and of Medical Students.

Certificates are awarded on the results of separate examinations on the subjects of the general and supplementary Lectures.

Fee for the Session, £3 3s.

Laboratory Course.

A class in Practical Chemistry meets for two hours weekly, to which Students attending the Lectures are admitted without additional fee. The Course consists of a series of qualitative and quantitative experiments, designed to give the Student a practical acquaintance with the principles of Chemistry regarded as a subject of general education.

The Laboratory is also open during the Session from 10 a.m. to 4 p.m., for instruction in Chemical Analysis. The fee is £10 10s. for the Session. Shorter Courses of Practical Chemistry will be arranged to meet the requirements of Students who cannot give so much time to the subject, the fees for which vary according to the number of hours taken weekly.

Several free places in the Laboratory will be given to Students desirous of engaging in original work. Applicants must satisfy the Professor that their studies are sufficiently advanced to admit of them prosecuting experimental research.

QUEEN'S COLLEGE, BELFAST.

Professor.—E. A. Letts, Ph.D., F.R.S.E., F.C.S.

The Session begins October 18th.

I.—*Chemistry.*—The lectures are delivered at 3 p.m., on the first five days of each week until the beginning of April, and on two days of each week after May 1st. The course is divided into three parts:—(1) Chemical Philosophy; (2) Inorganic Chemistry; (3) Organic Chemistry.

II.—*Advanced and Organic Chemistry.*—Lectures on these subjects are given from the beginning of the Session, on Tuesdays and Thursdays, at 10 a.m., until the beginning of April, and at 3 p.m. after May 1st.

III.—*Practical Chemistry.*—In this course the Students are instructed in the general methods of conducting Chemical Analyses.

IV.—*Laboratory Pupils.*—The Chemical Laboratory is open from November until the beginning of April, and from May 1st until the middle of July, on the first five days of the week, from 10 a.m. until 4 p.m. Students are admitted as working pupils on payment of a fee of £5 for the first period, or of £3 10s. for the second period (or for a single term).

QUEEN'S COLLEGE, CORK.

Professor.—Maxwell Simpson, D.Sc., M.D., F.R.S., &c.

The Session begins October 18th. The Chemistry Classes are held on Mondays, Wednesdays, and Fridays.

The Course is divided into Inorganic and Organic Chemistry.

In the first part are discussed the Laws of Combination and Affinity, Molecular Chemistry and Crystallography, and the History of the Non-Metallic and Metallic substances.

In the Organic portion of the Course will be considered the subjects of Organic Analysis, Organic Series, Compound Radicals and Types, Metamorphosis of Organic Bodies, History of Special Animal and Vegetable Bodies.

In treating of the Laws of Chemistry, and the History of Inorganic and Organic Bodies those points will be chiefly dwelt upon which have a practical bearing in the Arts, Medicine, Engineering, and Agriculture. Thence, during the Course, attention will be directed to the application of Chemistry to Medicine and Physiology, to Metallurgic Operations, Chemical Manufactures, Building Materials, Soils, and Manures.

Fee.—For each Sessional Course, £2. Each subsequent Course in Medicine, £1.

The Chemical Laboratory is open daily except on Saturdays, from 10 to 4 o'clock, under the Superintendence of the Professor, to Students desirous of prosecuting an extended course of qualitative and quantitative analysis, and for the purpose of original investigation in connection with the Arts, or in the higher departments of Scientific Chemistry.

ROYAL COLLEGE OF SCIENCE FOR IRELAND, STEPHEN'S GREEN, DUBLIN.

Professor of Practical and Theoretical Chemistry.—W. Noel Hartley, F.C.S.

The Session commences on Monday, October 3, 1887.

The instruction comprises courses of Lectures on General, Applied, and Analytical Chemistry, and also a course of Lectures on Metallurgy.

The Chemical and Metallurgical Laboratories, under the direction of Mr. Hartley, are open every week-day during the Session, except Saturday. Instruction is given in the different branches of Analytical Chemistry, including Assaying, and in the methods for performing Chemical Research. Fee, for the Session of nine months, £12; or for three months, £5; or for one month, £2.

There are four Royal Scholarships of the value of £50 each yearly, with Free Education, including Laboratory Instruction, tenable for two years; two become vacant each year; they are given to Students who have been a year in the College. There are also nine Exhibitions attached to the College, of the yearly value of £50 each. with Free Education, including Laboratory Instruction, tenable for three years; three become vacant each year.

A Diploma of Associate of the College is granted at the end of the three years' course.

Evening Classes.—Systematic Courses of Evening Lectures are given by most of the Professors throughout the Session.

CHEMICAL LECTURES, CLASSES, AND LABORATORY INSTRUCTION.

CITY AND GUILDS OF LONDON INSTITUTE FOR THE ADVANCEMENT OF TECHNICAL EDUCATION.—*Central Institution, Exhibition Road.*—Professor of Chemistry, H. E. Armstrong, Ph D., F.R.S. This Institution is intended to afford such practical, scientific, and artistic instruction as shall qualify persons to become—(1) Technical teachers; (2) Mechanical, civil, and electrical engineers, architects, builders, and decorative artists; (3) Principals, superintendents, and managers of chemical and other manufacturing works. Prominent among the agencies adopted is a scheme of Technological Examinations, in connection with which a large number of classes have been instituted in the various manufacturing centres of the kingdom at which practical instruction is given in the application of Science and Art to different industries. The work done in these classes is inspected by the Institute, and, on the results of the annual examinations, certificates and prizes are granted. The Matriculation Examination will be held on Tuesday, September 27th. *Technical College, Finsbury.*—Professor of Chemistry, Raphael Meldola, F.R.S. The College fulfils the functions of a finishing technical school for those entering industrial life at a comparatively early age; of a supplemental school for those already engaged in the factory or workshop; and of a preparatory school for the Central Institution. It is under the general direction of the Principal or Superinten-

dent of Studies. At the head of each Department is a Professor, who is assisted by one or more Demonstrators; and besides these there are Lecturers and Teachers for instruction in special subjects: Skilled Artizans are employed in the Workshops for the guidance of the Students. The Session is divided into three terms:—The Winter term commences on Tuesday, October 4th. An examination for the admission of Students will be held at the College at 10 o'clock on Thursday, September 29th, 1887, and the work of the Session will commence on October 4th. The instruction consists of Day and Evening Classes and Laboratory Instruction.

Birkbeck Literary and Scientific Institution, Bream's Buildings, Chancery Lane.—*Organic Chemistry:* A course of 30 Lectures, beginning on October 4th, at 7 p.m., by Mr. H. Chapman Jones, F.C.S. A supplementary Course of about twelve lectures for more advanced students begins in January. Laboratory work and Analysis on Tuesdays, from 6 to 8 p.m. Special facilities are provided for students preparing for the Second B.Sc. (London) Practical Chemistry Examination. *Inorganic Chemistry:* A course of Thirty lectures to Elementary Students, beginning on October 4th, and a course on Chemistry and Analysis to Advanced Students, beginning on October 8th, by Mr. George Chaloner, F.C.S. Classes for Practical Chemistry and Analysis on Tuesday and Saturday evenings, beginning on October 4th.

School of Pharmacy of the Pharmaceutical Society of Great Britain, 17, Bloomsbury Square.—The school opens on Monday, the 3rd of October. Lectures on Chemistry and Physics, by Prof. Wyndham Dunstan, on Monday, Tuesday, and Wednesdays, at 9 a.m. Lectures on Botany by Professor Green, on Friday and Saturday mornings at 9. Demonstrations in Materia Medica by Mr. Holmes, Curator of the Society's Museums, on Thursdays at 10 a.m. Lectures and Demonstrations in Pharmacy and Practical Pharmacy by Mr. Ince, on Tuesday, Thursday, and Friday, at 5 p.m. The Laboratories for Practical Instruction in Chemistry as applied to Pharmacy, &c., under the direction of Prof. Attfield, assisted by Mr. F. W. Short, will be open daily at 10 a.m. throughout the Session. They are fitted up with every convenience for the study of the principles of Chemistry by personal experiment. They are specially designed for the student of Pharmacy, but are equally well adapted for the acquirement of a knowledge of Chemistry in its application to Medicine, Manufactures, Analysis, or Original Research. There is no general class for simultaneous instruction, each student following an independent course of study always determined by his previous knowledge; pupils can therefore enter for any period at any date. Fees for the Lectures: Chemistry, One Course, (five months), £3 3s.; an entire Session—Two Courses, £4 4s.; Perpetual Admission, £5 5s. Botany—One Course, £2 2s.; Session, £3 3s.; Perpetual Admission, £4 4s. Pharmacy—One Course, £2 2s.; Session, £3 3s. For Practical Chemistry, 10 months, 12 to 25 guineas, according to hours of attendance. *Council Prizes.*—At the end of each of the five months Courses of Lectures, a Bronze Medal and two Certificates of Honour, and at the close of the Session (ten months) a Silver Medal and three Certificates of Honour are offered for competition by the Council. In the Class of Practical Chemistry, a Silver Medal, two Bronze Medals, and seven Certificates of Honour, offered by the Council, are competed for at the end of the Session. In the Materia Medica and Pharmacy Classes a Bronze Medal is offered for competition at the end of each Course, and a Silver Medal at the end of the Session.

New Central School of Chemistry and Pharmacy, 173, Marylebone Rd., London.—Mr. J. Woodland, F.C.S., In addition to the usual Chemical studies, Special Instruction Classes are held for Students of Medicine.

South London School of Pharmacy, 325, Kennington Road.—Dr. John Muter, F.C.S. Daily, at 9 a.m. Lectures on Theoretical Chemistry, and Junior and Senior Course of Practical Chemistry.

Onslow College of Science, 183, Kings Road, Chelsea, S.W.—Lectures and Laboratory instruction in Chemistry and Pharmacy. Special Evening Classes in Inorganic and Organic Chemistry, &c. The Chemical and Metallurgical Laboratories are open every day and evening for practical work. Principal, Mr. W. H. Martin.

Royal Victoria Hall, Waterloo Bridge Road, S.E.—Science and Technical Classes, Session 1887-88. Lectures will be given in the following subjects:—Electricity and Magnetism, L. H. Owen, Esq.; Animal Physiology, Dr. Drew, B.Sc.; and Chemistry. Classes are also held in Mathematics, Plane and Solid Geometry, Machine Construction and Drawing, Applied Mechanics, and Commercial Arithmetic. The instruction given is suited to artizans and practical men, and is chiefly in connection with the Science and Art Department, South Kensington.

Charterhouse Science and Art Schools.—Commence Saturday, October 1st, 1887. Instruction of a practical character is given in most of the Sciences at a very nominal fee; whilst in Art, at an equally low rate, Students, under the direction of five competent instructors, can be advanced in their studies. Those who have leisure can, at a very moderate charge, attend the Day Classes in Art. Day Classes will also be held to prepare Candidates for Matriculation (Lond.), the Clerical, Medical (including Dental), Legal, and other Examinations. Students who aim at becoming proficient in Chemistry (Organic and Inorganic) have the opportunity of working in a well-fitted Laboratory, capable of accommodating sixty Students. Aspirants of University Honours can at a small expense be assisted in their studies.

Portman School of Pharmacy, 156, Marylebone Road, Regent's Park.—Principal, Mr. F. H. Painter.

City Commercial Laboratories, 18 and 19, Fenchurch Street, S.E.—Messrs. Cannon and Newton.—Special instruction in Commercial Analysis.

Bedford College (Ladies).—Mr. S. U. Pickering, F.C.S.—Lectures commence October 15th. In the Junior Class the subjects taken are those suited for the London Matriculation Examination, while in the Senior Class the subject matter is mainly that of the Intermediate and Prel. Sci. Examinations.

Westminster College of Chemistry and Pharmacy, Trinity Square, Borough, S.E. — Messrs. Wills and Wootton.

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Bristol Medical School.—Mr. T. Coomber, F.C.S.

College of Chemistry, Royal Institution, Hull. Professor, G. Carr Robinson, F.R.S.E., F.I.C., F.C.S. Lectures on Inorganic and Organic Chemistry and on the Manufacture of Oils, Colours, and Varnishes are given during the Winter months. Winter Session begins first week in October.

Institute of Chemical Technology, Hackins Hey, Liverpool.—Principal, Mr. A. Norman Tate, F.I.C. The course of instruction is intended more especially for students who wish to gain a knowledge of chemistry and the allied sciences in their relation to industrial and commercial pursuits, and embraces a thorough preliminary course of theoretical chemistry and practical laboratory work, followed by instruction in chemical technology fitted to the requirements of each pupil. In addition to these chemical studies, students who desire it can enter upon a special course calculated to afford them knowledge useful in the erection and arrangement of manufactories and plant, and construction of apparatus.

Leeds School of Medicine.—Prof. Smithells.

School of Science of the City and County of Lincoln.—Head-Master and Professor of Chemistry, Dr. A. B. Griffiths, F.R.S. (Edin.) F.C.S., &c. Commence September 27th, 1886. The Chemical Laboratory is fitted with every appliance, apparatus, &c., essential for furnishing a well-appointed Laboratory. The Chemical Lecture Theatre is capable of holding 300 Students. Day Lectures on Advanced Inorganic and Organic Chemistry will be given by Dr. Griffiths during the Session. These Lectures will meet the requirements of the B.Sc. (Hon.) and M.B.

Examinations of London University, &c. Mr. J. W. Horton, F.R.M.S. (Demonstrator on Chemistry) will give Junior Lecture Courses on Inorganic Chemistry, and also Lectures on Technical Chemistry. There will be Courses of Lectures on Agricultural Chemistry with Laboratory Practice, by Mr. Wallis, superintended by Dr. Griffiths.

School of Science and Art, Newcastle-on-Tyne.—Chemistry and Metallurgy, Mr. P. Hawkridge, B.A.; and Mr. R. H. Jude, M.A., D.Sc.

Sheffield Borough Analysts' Laboratory, 1, Surrey Street.—Mr. A. H. Allen, F.C.S. Day and Evening Classes.

Swansea School of Chemistry and Metallurgy, Nelson Terrace.—W. Morgan, Ph.D., F.C.S.

University of Aberdeen.—Mr. J. S. Brazier, F.C.S.

The College of Science and Technology, Edinburgh.—J. Gibson Fairweather, B.Sc., C.E., Director.—Established chiefly to promote Technical Education among Artizans by opening classes in several centres in Edinburgh, as well as the promotion of classes for assisting University Students and others in preparing for the various Science and other Degrees either in the University of Edinburgh or University of London.—Evening classes.

School of Medicine, Surgeon's Hall, Edinburgh.—Dr. Stevenson Macadam, F.R.S.E., Mr. Falconer King, Mr. Ivison Macadam, and Mr. Drinkwater.

Edinburgh School of Pharmacy and Chemistry.—The instruction qualifies for graduation in Medicine and Science in the University of Edinburgh and other Examining Boards. Secretary, Mr. R. Urquhart.

Edinburgh School of Medicine, 41, Chambers St.—Dr. Drinkwater, F.C.S.—The instruction here qualifies for all Medical Boards, Edinburgh University, London University, &c. Day andEvening Classes.

Minto House Medical School, Chambers Street, Edinburgh.—Mr. J. Falconer King, F.I.C., F.C.S. Lectures and Classes.

New Veterinary College, Leith Walk, Edinburgh.—Professor Ivison Macadam.

Glasgow University.—Prof. J. Ferguson.

Glasgow Veterinary College.—Professor Cooke.

School of Chemistry, 138, Bath Street, Glasgow.—Dr. Wallace, Mr. Tatlock, and Dr. Clark. Day and Evening Classes.

Chemical Laboratory, 180, West Regent Street, Glasgow.—Dr. Milne. Day and Evening Classes.

Queen's College, Galway.—Dr. T. H. Rowney.

Royal College of Surgeons in Ireland, Dublin.—Professor of Chemistry and Hygiene: Sir Charles A. Cameron, M.D., F.R.C.S.I. Chemical Demonstrators: F. Heron, B.A., F.I.C.; P. A. Peil; and J. Macallan, F.I.C.—Instruction is given in the College Laboratory in General, Practical, and Analytical Chemistry, and in the subjects (Physical, Chemical, and Microscopical) required for Examinations in Public Health and to educate for the position of Public Analyst.

Albert National Agricultural Institution, Glasnevin, Dublin (under Commissioners of National Education).—Professor of Chemistry and Geology: Sir Charles A. Cameron, M.D.

Dublin, Carmichael College of Medicine.—Professor of Chemistry: C. R. C. Tichborne, Ph.D., F.C.S.

Dublin, Catholic University.—Dr. Campbell.

Colorist, experienced in the Manufacture of Printed Cotton, seeks a Situation.—Address, A. I., 513, care of Messrs. Haasenstein and Vogler, Cologne.

Wanted Railway Tank Waggons to carry 10 to 12 tons each.—Address, V, "Courier" Office, Halifax.

Wanted, Practical Chemist. Must be thoroughly up in Lubricants of all kinds (Oils, Grease, &c.), and accustomed to imitate or make Duplicate Samples of Commercial Products submitted to him for examination. No application will be entertained unless the fullest information be given as to past experience. State salary expected.

OWEN'S COLLEGE, VICTORIA UNIVERSITY, MANCHESTER.

CHEMISTRY COURSE.

Full particulars of this COURSE, qualifying for the VICTORIA University Degree in Chemistry and the College Technological Chemistry Certificate, will be forwarded on application. The Session commences October 4th.

H. W. HOLDER, M.A., Registrar.

THE MASON COLLEGE, Birmingham.

SESSION 1887-88.

FACULTIES OF ARTS AND SCIENCE.

The NEXT SESSION commences on MONDAY, October 3rd.

No Student will be admitted under the age of 16 without having passed a Preliminary Examination.

Syllabuses, containing complete information as to the various Courses of Instruction, Fees, Lecture Days and Hours, Entrance and other Scholarships, Prizes, &c., may be obtained from Cornish Bros., New Street, Birmingham, price 3d., by post 4½d.

GEO. H. MORLEY, Secretary.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE.

DEMONSTRATOR AND ASSISTANT LECTURER IN CHEMISTRY. Stipend £120 a year.

ASSISTANT LECTURER IN MATHEMATICS. Stipend £100 a year.

The above appointments are now vacant. Applications, together with testimonials, must be sent in on or before Saturday, October 8th, 1887, to the undersigned, of whom all further particulars may be obtained.

IVOR JAMES,
Cardiff, September 6, 1887. Registrar.

UNIVERSITY COLLEGE, BRISTOL.
CHEMICAL DEPARTMENT.

Professor—SYDNEY YOUNG, D Sc.
Lecturer—ARTHUR RICHARDSON, Ph.D.

The SESSION 1887-88 begins on 5th OCTOBER. Lectures on Inorganic, Organic, Advanced, Technical, and Photographic Chemistry will be delivered during the Session. The Laboratories are fitted with the most recent improvements for the study of Practical Chemistry in all its branches. In the evening Lectures on Inorganic, Technical, and Photographic Chemistry at reduced fees are delivered. Several Scholarships are tenable at the College. Calendar, containing full information, price 1s. (by post 1s. 3d.). For Prospectus and further information apply to the Registrar.

JENKINS' PATENT GATE VALVES
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THE CHEMICAL NEWS.

VOL. LVI. No. 1452.

THE RELATION OF SCIENCE TO THE STATE.

THE relation of Science and of scientific men to the State is a question of such moment to the well-being and the progress of the whole community that we are led to venture upon its re-consideration. But at the very outset we meet with a fundamental difficulty. We find the term "Science" used, even by persons of education and eminence, with a sad want of precision. In sermons and orations, in newspaper articles, and even in standard works, homœopathy, aëronautics, photography, navigation, bicycling, bill posting (!), and a mixed multitude of pursuits having no mutual connection, are spoken of as "Sciences." Science is even reproached for such evils as railway accidents, dynamitards, factory chimneys, and in short for anything of recent origin which the speaker dislikes. We have even seen it intimated in a young contemporary, that Art (probably Fine Art) is something "done" for love, whilst Science is "done" for money! No more complete misconception of the very nature of Science could be expressed in so few words.

Before, therefore, entering upon any question as to the relations of Science to the State we must, under penalty of being misinterpreted, define Science. In attempting so to do we shall be to a great extent guided by the most eminent authorities who have discussed this question. This we do with the more confidence as their conclusions are substantially unanimous, and, though often ignored, have never been formally controverted.

Thus the late Sir J. Herschel declared Science to be "knowledge digested and methodically arranged," and in another passage he defines it as the "search for laws." In a very similar manner Baron Humboldt pronounced the object of Science to be the discovery of laws. Prof. W. Whewell explains Science as the "interpretation of Nature." Sir William Grove holds it to be the "search for facts and their relations."

The late G. H. Lewes considered Science as "a knowledge of the laws of Nature," "the explanation of the phenomena of the universe," and adds that it gives us the power to "see and to foresee,"—in other words, to predict phenomena.

Everyone who carefully examines these definitions will see that they differ merely in expression, and are in their spirit identical. This becomes still more plain on reading over the works from which these passages have been selected as summarising the views of the respective anthors.

Before, however, proceeding to an exposition of the principles—or rather principle—just laid down, we must explain two terms made use of in the above definitions.

We have found mention of "phenomena." Now what is a phenomenon? It is painful that such a question need be asked. Phenomena are whatsoever we recognise by the agency of our senses, as contradistinguished from *noumena*, the supposed underlying causes of our sense-impressions. Half a century ago this was the only acceptation in which the term was used among educated men. There is in it no reference to anything unusual or surprising. The fall of a pebble released from our grasp is as much a phenomenon as the earthquake of Krakatoa. But showmen, strolling actors, and the like, *suadente diabolo*, began to apply the term to anything novel or surprising, and their example has been strangely followed. Thus in medical works we find powerful remedies, strong poisons, &c., spoken of as "phenomenal agents." In one of the reports of an influential scientific institution we saw giants and dwarfs classed as men of "phenomenal stature." Against this corruption of language we must protest, and warn all whom it may concern that in the phrase "phenomena of the universe" the word is not to be thus misunderstood.

There is then the unhappy term "laws" used in several of the definitions above quoted. Sir J. Herschel remarks that this use of the word *law* "has relation to us as understanding, rather than to the universe obeying, certain rules. To *obey* a law, to act in *compliance* with a rule, supposes understanding and will in the being who obeys and complies." But can we conceive of atoms, molecules, cells, or forms of energy as understanding and willing?

G. H. Lewes regards the term *law* as "inaccurate and misleading." A law, instead of being a mere relation of co-existence and succession, is, half unconsciously, considered to be "an abstract entity superadded to the facts, which coerces such facts and makes them to be what they are." The frequency of such expressions as "breaking the laws of Nature" proves how misleading is the term.

We are now in a position to distinguish Science from pursuits or studies with which it is often confounded. It is not mere knowledge. No accumulation of facts, however important in themselves, and however accurately observed and faithfully recorded, constitutes a Science. They must be co-ordinated, and shown forth in their relations of co-existence and succession. If this has not yet been done, or if from the arbitrary and casual nature of the facts it cannot be done, the study is erudition or learning, but not Science.

Science must also be carefully distinguished from the Arts, whether fine, useful, or useless. Here it is that the confusion we complain of is the most rampant. But the difference is easy to seize. Science sees phenomena, records them, traces their laws, and to this end questions Nature, her sole object being truth. Where completely successful she attains prevision.

Art, on the contrary, seeks to produce, to modify, or to destroy. Her sphere is action. She aims at power and enjoyment, and where completely successful she creates.

It is scarcely needful to insist that between these two pursuits there exist very intimate relations. Science is indebted to Art for her means of interrogating Nature by experiment. On the other hand, she instructs Art concerning the properties and the laws of the materials upon which the latter seeks to operate. Strictly speaking there is no such thing as "Applied Science." The moment we seek to apply we pass into the realms of Art.

But close as is the relation between Science and Art, and necessary as they are to each other, they must not be confounded, differing as they do in their objects. If we hear any pursuit spoken of as a Science, we must simply ask whether it is an attempt to interpret Nature, or to explain the phenomena of the universe? If not, however beneficial and laudable such pursuit, it is not Science.

In like manner when we hear a person designated as a "scientific man," we inquire if he is observing phenomena and tracing out their laws? If not, however vast his knowledge of the results reached by others, he is not a "man of Science."

Professor Dittmar, of the Glasgow and West of Scotland Technical College, is about to publish a series of Exercises in Quantitative Chemical Analysis, with a Treatise on Gas Analysis. The publishers are Hodge and Co., Glasgow.

Massachusetts College of Pharmacy.—We have received the Twenty-first Annual Catalogue of the College for 1887-88, in which can be found an interesting historical sketch of the origin and growth of Pharmacy in America. There is a complete list of the courses of instruction and conditions of entrance, &c., and we note especially that "women are admitted under the same conditions and with the same privileges as men."

PRELIMINARY NOTICE OF A RE-DETERMINATION OF THE ATOMIC WEIGHT OF GOLD,

With Some Remarks on the Present State of our Knowledge as to the Determination of Atomic Weights in General.

By Prof. J. W. MALLET, F.R.S.

For the last two years experiments had been in progress looking to as exact a determination as possible of the atomic weight of gold, for which, until recently, there had been but very few data. Within the last few months the results had been published of two researches on this subject by others, namely, by Krüss in Germany, and by Thorpe and Laurie in England. Yet the author's work was continued, since there can scarcely be too much verification of important constants, and the methods adopted were not altogether the same as those used by the other chemists named, all whose results were obtained by essentially one and the same process. Such liability to error as belongs to this process was pointed out.

The author's own work has not yet reached the point of giving final results for publication, but the probability seemed to be that a rather higher value would be found for the atomic weight in question than that assigned by other experimenters.

It was suggested that the most important direction for advance in our knowledge of atomic weights is that of endeavouring to eliminate "constant errors," as distinguished from mere personal or casual errors of experiment. The latter we have been taught, by the example of Stas, to reduce to very small values by minute and elaborate precautions. But the former are always to be suspected, and all conceivable means should be used to avoid them. Among the most important of such means the following were pointed out:—

1st.—Resort in every case for the purification of materials used to "fractional" methods, assuming materials to be pure only when earlier and later fractions give sensibly identical results.

2nd.—Great care in the study of the reactions depended upon for final determination of atomic weights, looking especially to any possibility of the occurrence of secondary or subsidiary reactions.

3rd.—Adoption of methods by which (*a*) the atomic weight to be determined may be connected *directly* with that of hydrogen, or (*b*) if connected indirectly, by the intervention in each single determination of as *few* other elements, but in determinations by different methods, of as *many* other elements as possible of supposed well-known atomic weight.

Under this last head a method was described which had been resorted to by the author in his work on the atomic weight of gold, affording a direct connection with that of hydrogen—a method which the author believed capable of more extended application in the determination of the atomic weights of other elements. Zinc was prepared of a high degree of purity, and a given weight of the metal having been dissolved in dilute sulphuric acid, the amount of hydrogen evolved was determined by volume. A solution of auric bromide or chloride as pure as possible was treated with a known quantity of the same zinc, more than sufficient for the precipitation of the gold; the excess of zinc was dissolved by dilute sulphuric acid, and the volume of hydrogen given off was determined. The precipitated gold was carefully collected, washed, dried, and weighed. The difference between the volume of hydrogen which the zinc gave when thus partly used to replace a known quantity of gold, and the volume which it would have given if replacing hydrogen only, taken in connection with Regnault's determination of the relation of weight to volume for hydrogen, afforded of course the data needed for a direct comparison of the weights of gold and hydrogen concerned. It was pointed out that in applying this process the weight of the gold salt in solution need not be known, and that the method is not dependent upon a knowledge of the atomic weight of the halogen, combined with the gold, or of the atomic weight of zinc, and does not even require that the zinc shall be of assured purity, provided only it be uniform in character, so that a given weight of it can be depended on to yield always the same quantity of hydrogen, and there be no impurities present capable of interfering with the collection of the precipitated metallic gold in a state of purity.

* Read before the Chemical Section of the British Association, Manchester Meeting.

ON THE ANTISEPTIC PROPERTIES OF SOME OF THE FLUORINE COMPOUNDS.*

By WILLIAM THOMSON, F.R.S.Ed., F.C.S.

Some time ago I was engaged in trying to find a substance which would act as a powerful antiseptic, &c., which was not volatile, and which was not destroyed by oxidation. I tried the effects on flour paste, and on meat chopped into small pieces and mixed with water, of a very large number of chemical compounds, and found that those which had the most remarkable antiseptic properties were the compounds of fluorine, hydrofluoric acid, the acid and neutral fluorides of sodium, potassium, and ammonium, and the fluosilicates of those bases. Of these compounds I found sodium fluosilicate to be the one which, for its powerful antiseptic and unobjectionable properties, was perhaps the best suited for the general purposes of an antiseptic. This body is not poisonous, possesses no smell, and is sparingly soluble in water. It has only a very slightly saline taste, and may be therefore employed for preserving food without communicating any taste to it.

Many experiments have been made with it for surgical purposes. A saturated solution which contains 0·61 per cent of the salt is not irritating to wounds, whilst it possesses greater antiseptic power for animal tissues than one part of perchloride of mercury in 1000 of water, which is a stronger solution than that which can be generally employed for surgical purposes without producing poisonous effects.

* Read before the Chemical Section of the British Association, Manchester Meeting.

THE REDUCTION-PRODUCTS OF THE NITRO-PARAFFINS AND ALKYL NITRITES.*

By Professor DUNSTAN and T. S. DYMOND.

The reduction-products of ethyl nitrite have been investigated by Geuther, who used zinc and diluted sulphuric acid as the reducing agent, and found that the change represented by the equation—

$$C_2H_5NO_2+2H_2=C_2H_5OH+NH_3$$

takes place. A trace of ethylamine was also formed, but this has been attributed to impurity in the ethyl nitrite. Emil Kopp used ammonium sulphide as the reducing agent, and also obtained alcohol and ammonia, but no trace of ethylamine.

The authors have studied the reduction of ethyl nitrite, using ferrous hydroxide as the reducing agent, and have obtained an entirely different result. More than two-thirds of the nitrogen of the ethyl nitrite is liberated in the form of gas, either nitrous oxide or nitrogen; the remainder appears partly as ammonia and partly as ethylamine. If potassium hydroxide is mixed with the ferrous compound a considerable quantity of potassium hyponitrite is formed. It is also probable that ethyl hyponitrite, a compound that

has not yet been prepared, may also be formed as an intermediate compound. The authors are further investigating the change with the object of isolating this compound and of discovering the mode of formation of the ethylamine.

The reduction-products of the nitroparaffins have been studied by Victor Meyer. Nitroethane was reduced, by iron and acetic acid, to ethylamine without the formation of any ammonia:—$C_2H_5NO_2+3H_2=C_2H_5NH_2+2H_2O$. When ferrous hydroxide is used the authors find that much ethylamine is produced, a little ammonia, and a substance having a strong alliacious smell, which is being further investigated:—No gaseous product is formed. Nitromethane yields, under the same condition, methylamine, a little ammonia, and a substance having an alliacious smell. Nitro-benzene is entirely converted into aniline. The authors have previously shown (*Journal of the Chemical Society*, August, 1887) that sodium nitrite is reduced by ferrous hydroxide to nitrogen and ammonia, sodium hyponitrite being formed as an intermediate product. They intend to further investigate the reduction of the alkyl nitrites, mainly in the hope hope of being able to throw some light on the constitution of the inorganic nitrites.

ON THE MANUFACTURE OF BUTTERINE.

By THOMAS T. P. BRUCE WARREN.

We must congratulate ourselves that recent legislation on this subject will help to unmask a manufacture which has hitherto taken refuge under a name so closely resembling butter.*

I remember, about two years ago, a question on butterine was answered in the House of Commons by a distinguished member, "that it was inexpedient to interfere with the manufacture of a wholesome article of food."

All manufacturers of what we must now call margarine are not equally scrupulous as to what they use. It is perfectly true that fat which is *doubtfully fit* for food may be so purified in the operations of converting into the so-called margarine that it passes off as wholesome (?), but, as it has been recently pointed out, an animal may be slaughtered in a diseased condition, or the fat may be infested with maggots or other organisms, and so we may get our *wholesome substitute* for butter derived from a source decidedly unpleasant to think about.

It would have been better f the Margarine Bill had contained a clause authorising i nspection, so as to prevent obnoxious materials being used. Clause 9, however, directs that "every manufactory of margarine within the United Kingdom of Great Britain and Ireland shall be registered," so that we have some consolation on this point.

It is a notorious fact that good margarine costs more than some butterine is sold for. The manufacturer of margarine is not in every case the manufacturer of butterine; the margarine is agitated with milk, and cooled down until it thickens; sometimes butter itself is added, if the article is to pass off as as a veritable dairy product. Every day, almost, adds something new for the distraction of our analysts, and I fear that for some time to come the "Margarine Act 1887" will be a fruitful source of vexation.

I extract the following from the *Standard* of August 29:—"The latest vegetable fat to attract commercial attention is an extract of the *Myristica sebifera*, a so-called bean, but really a species of nutmeg, which grows wild in Guatemala, where the natives gather it and obtain the oil from it for soap and candles. The beans are in abundant supply, growing in bunches on the bushes, and they can be had at the small expense of paying Indians to gather them. A Consular Representative of Guatemala in the United States is of opinion that there is a great future in store for the fat of this vegetable, which he thinks would be a 'good substitute' for lard or butter. Machinery for crushing sesame seed, which is extensively cultivated in Guatemala, is now being sent into that country. The oil is to be exported to the United States."

I have not met with the fat of the *Myristica sebifera*, but the announcement respecting the sesame oil is significant. I may call the attention of those who are interested in this matter to an article on the Adulteration of Oils which appeared in the Chemical News (vol. lv., p. 134). I may just add here that if sesame oil is to replace cotton oil in the manufacture of oleo-margarine, its presence can be even more easily detected than cotton oil.

* Margarine Act, 18 7.

SEPARATION OF GOLD FROM THE PLATINUM METALS.

By W. BETTEL, Metallurgist.

In the paper by L. Hoffmann and G. Krüss (Chemical News, vol. lvi., p. 83) certain assertions are made which, if allowed to pass unchallenged, would still further add to the "current statements" the authors complain of as being "in part defective and in part inaccurate."

1. *Separation by Sulphurous Acid.*

It is said by the authors that the determination of gold by precipitating its solutions with sulphurous acid is not proposed in any accessible text-book on analytical chemistry. Surely the authors would not have us believe that analytical chemists are unaware of the reducing properties of the sulphites applied to analysis! Personally I have used sulphites and sulphurous acid in analyses of gold and platinum metals—where iron was objectionable—for the past five years, and would remark that, to succeed in the separation and precipitation of gold from mixed solutions, the same conditions (*acidity*, dilution, and temperature) required for reducing an iron assay by SO_2 or sulphites applies to gold solutions. If too neutral platinum is precipitated (in traces); all the gold is not precipitated if the solution is too acid, and other causes determine the separation of a part of the gold in so finely a divided form that months are required to precipitate the last traces.

A happy medium—found by practice—secures the precipitation of 100 per cent of the gold of a purity of 999·9 per 1000. If, however, only traces of gold are to be precipitated from platinum, &c., solutions, it has been my practice to purify the resultant precipitated gold by cupellation with silver, and parting the bead obtained. It is usual, however, to throw down the platinum as double chloride, and estimate the gold in filtrate, either before or after separating palladium and traces of iridium, according to requirements.

When platinum and palladium deposits are under examination one has to attend to separation of arsenic, lead, bismuth, copper, iron, graphite, phosphorus compounds, and silica, so the mere knowledge of what takes place in neutral solutions of platinum and gold when heated with SO_2 (I am writing of *accurate* knowledge) is only an analytical curiosity to be trotted out at rare intervals.

2. *Precipitation of Gold by Oxalic Acid.*

Our authors neglect the precaution to neutralise the gold solution, and to provide for gold carried forward by evolved CO_2 and spitting. I have several times had to analyse gold (from nitric parting process) supposed to contain platinum metals, and used to take from 2000 to 5000 grains for isolation of impurities. In all cases where I have used oxalic acid as a precipitant I have returned to the office the full assayed contents of gold. (For such

large quantities of gold SO_2 is not a suitable precipitant, on account of the H_2SO_4 produced. I have used formic acid and formates with success.)

3. *Precipitation of Gold by Ferrous Chloride, and Separation from Platinum (and Palladium).*

I now come to a serious error (or "a statement in part defective and in part inaccurate") from a manufacturing point of view).

The authors seriously affirm on their unsupported testimony (in variance to Rose and Fresenius too!) that gold precipitated by ferrous chloride, from mixed solutions of gold and platinum (and palladium), contains a notable quantity of the associated metals. To quote their words:—

"According to the above analyses the gold precipitated by ferrous chloride is platiniferous."

And the "analysis" shows that 100·24 per cent of gold was obtained by such precipitation (in presence of platinum), and a maximum of 100·62 (in presence of palladium); in other words, that in solutions of gold and platinum, or palladium, a gold of purity, 997·6 per 1000, was obtained in the first case, and only 993·8 (!!) in the second.

Before I treat further of this analytical curiosity, allow me to give you an idea of my personal knowledge of the matter. I have had between five and six years' experience as a metallurgist and analytical chemist in two large refining and smelting establishments, where I had control and direct supervision over refining gold, silver, platinum, iridium metals, and palladium, by nitric, sulphuric, and aqua regia methods (precipitation by ferrous salts), &c., and separation of platinum metals from lead, bismuth, arsenic, copper and iron salts, and returning the pure metals to the office for sale. All assays, analyses, and examinations of fine metals and resulting residues, deposits, and precipitates were made by me, the accuracy of my results being periodically checked by the chief London assayer; and still I was unaware of the fact (?) that the gold I had seen, handled, assayed, and analysed was so impure. On the contrary, after the experience derived from refining over *three tons* of gold by the aqua regia process (every bar of from 100 to 300 ounces being accurately assayed to the exact decimal per 1000), I have no hesitation in saying that the statement is grossly misleading, for it being so easy to obtain (at a less cost than "nitric parting") gold of an almost chemical purity, that, at the establishment I was at the time connected with, if the refiner returned to the office a bar of gold assaying less than 999·5 per 1000 *he was not paid for that refining* (the work being done by contract, at so much per ounce of gold from sulphuric boiler), and I can personally vouch for the statement that from "platiniferous" gold assaying about—

	Per 1000.
Gold	750
Platinum metals	200
Silver and impurities	50
	1000

a gold assaying from 999·6 to 999·9 *can* be easily obtained, and, further, the principal impurity in golds assaying less than 999·9 per 1000 was silver. This is the result of over a thousand double and triple assays. I can give an additional proof of the inaccuracy of Messrs. Hoffmann and Krüss's statement.

When we wanted any "proof" gold assaying from 999·9 to as near 1000 as assays can go, I used to supervise the settling, syphoning, and precipitation of the gold, and washed the metal obtained with pure hydrochloric acid and filtered steam-water, dried and melted the precipitate with a suitable flux, and poured into a mould lined with pure carbon. The last lot of proof gold so prepared was assayed as under:—

	Per 1000 of Gold.
Johnson, Matthey, and Co.	1000·0
Claudet	999·9
Johnson and Son	999·95
W. B. (average of 3)	999·95

The assay fineness was taken for "proof" purposes at 999·9. This was prepared from an ordinary platiniferous gold which always contains palladium.

Once (at the larger of the two refineries I have been engaged in) we got platinum in our gold in a curious manner. One Monday morning—the gold having been precipitated on Saturday—the refiner called my attention to the curious appearance of the gold; beautiful cubical crystals of an orange colour, and about $\frac{1}{20}$th of an inch cube adhered to the precipitated gold. I turned to the workman and said "Why, W——, you have been putting your platinum mother-liquors (containing AmCl) in the 'ironing' jars." This he admitted he had done by an oversight. The gold assayed 995·0 per 1000, and was reworked, but the platinum came down as double chloride, not as metal.

May I suggest that impurities caused precipitation of platinum in Messrs. H. and K.'s case? At any rate I think their solitary analysis has not shaken my belief in the accurate methods of Rose and Fresenius (who have made few mistakes), to whose excellent works I am ndebted for many valuable hints in elaborating processes o meet my requirements in the works' laboratory.

The Gold, Silver, and Platinum Refinery
of Messrs. Lees and Sanders, Birmingham.

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT.

Fellow of the American Association for the Advancement of Science; Member of the Academy of Natural Sciences, Philadelphia; of the Berliner Chemische Gesellschaft, &c., &c.

(Continued from p. 103).

Aqueous Extracts.

Extract (1), *Bark of the Root.*

The residual powder was thoroughly dried from alcohol. It was returned to the percolator, and cold distilled water added until a definite amount had been used. The *aqueous extract* was dark coloured, and of a faintly acid reaction. A certain quantity of the *extract* was evaporated, dried, and weighed. From a known weight of the *aqueous residue*, the ash was calculated. The incineration was conduced in a covered porcelain crucible of known weight.

Total Solids.

	Per cent.
Aqueous residue dried between 100° C. and 110° C.	4·00
,, ,, ash	2·65

Gum.

One volume of the *aqueous extract* was mixed with two volumes of Squibb's stronger alcohol. The mixture was kept in a cool place for twenty-four hours, and the precipitate which had formed was collected on a weighed filter, washed with 66 per cent alcohol, dried and weighed. The precipitate and filter were incinerated in a weighed porcelain crucible, and the weight of the filter being deducted, the percentage of ash was determined.

	Per cent.
Weight of precipitate by stronger alcohol yielded	2·0
,, ,, ash yielded	0·2

Another portion of the *aqueous extract* was precipitated by stronger alcohol, and the precipitate consisted of gum and albuminous substances. It was incompletely soluble in water. The soluble matter was gum, it was recovered from solution by evaporating the liquid to dryness. The

gummy residue was almost completely soluble in cold water. It was precipitated from a concentrated aqueous solution by stronger alcohol; basic acetate of lead precipitated it as a flocculent precipitate. Borax did not thicken the gum solution, and ferric chloride and sodium chloride solutions did not precipitate it. The gum was boiled with dilute acid, and heated over a water-bath with Fehling's solution, which it reduced. A few drops of hydrochloric acid and stronger alcohol were mixed with the concentrated gum solution for the separation of arabin. It was not separated.

Carbhydrates.

The filtrate and wash alcohol from the gum precipitate were mixed, and evaporated to a syrupy consistency at a temperature of 70° to 80° C. The concentrated solution was treated with four volumes of stronger alcohol, and the resulting precipitate of *carbhydrates* rapidly filtered off. It was soluble in water. It was not precipitated from aqueous solution by basic acetate of lead, and by this means it was distinguished from vegetable mucilage.

The *carbhydrates* were boiled with dilute acid, and the solution was rendered alkaline, and heated over a water-bath with Fehling's solution. The latter was reduced.

The percentage of *carbhydrates* as estimated amounted to 0·2 per cent. An aqueous *carbhydrate* solution was mixed with a solution of barium in 40 per cent alcohol. It yielded no precipitate.

Carbhydrate Filtrate.

The *carbhydrate filtrate* was concentrated at a low temperature in a current of carbonic acid until the alcohol was dissipated. The *residue* was examined for glucose, organic acids, saponin, and tannin. Traces of glucose were detected qualitatively by Fehling's test; the amount of cuprous oxide present was too small to estimate gravimetrically. A part of the *carbhydrate filtrate residue* was boiled with 83 per cent alcohol, and filtered while hot. On cooling, a precipitate formed. This precipitate was identified as saponin. It was almost insoluble in stronger alcohol. Baryta-water precipitated it from aqueous solution. Its aqueous solutions frothed on shaking. When agitated with chloroform and on evaporating the chloroform solution, a light-coloured residue was obtained. A few drops of concentrated sulphuric acid mixed with it gave a reddish violet colour reaction. Another portion of the *carbhydrate filtrate residue* was precipitated with neutral acetate of lead and filtered. The precipitate was suspended in water, decomposed by sulphuretted hydrogen, and the lead sulphide filtrate evaporated over a water-bath to expel all odour of sulphuretted hydrogen. The liquid was cooled and lime-water added until the reaction was alkaline to litmus. A turbidity formed when the lime-water was added to the filtrate, and was not entirely cleared on the addition of dilute acetic acid. A neutralised portion of the lead sulphide filtrate gave a yellow precipitate with a ferrous salt. Oxalic acid by these tests was indicated, and possibly other vegetable acids were present in the filtrate. The *carbhydrate filtrate residue* was examined for tannin, and with a negative result. Calcium oxalate was separated.

Extract (2), *the Wood of the Root.*

The powder used in the alcoholic maceration was thoroughly dried, and replaced in the percolator. A measured quantity of cold distilled water was allowed to percolate slowly through the powder. The *extract* was coloured, and slightly acid in reaction. A definite volume of the *extract* was evaporated, dried, and weighed. A known weight of the *residue* was incinerated in a weighed covered porcelain crucible, and the ash determined. The ash was white and incompletely soluble in water.

Total Solids.

	Per cent.
Aqueous residue dried between 100° and 110° C. ..	12·10
,, ,, ash	1·74

Gum.

A certain quantity of the *aqueous extract* was mixed with two volumes of stronger alcohol (Squibb's). The mixture was allowed to stand for twenty-four hours, and the precipitate which formed was collected on a weighed filter. It was dried, and weighed. The precipitate and filter were incinerated in a weighed porcelain covered crucible, and the percentage of ash calculated.

	Per cent.
Weight of precipitate by stronger alcohol yielded	1·70
,, ,, ash yielded	0·34

Carbhydrates.

The filtrate and wash-alcohol from the gum precipitate were concentrated at a low temperature, and the residue was mixed with four volumes of stronger alcohol. The precipitate was rapidly filtered off, and the percentage of *carbhydrates* calculated gravimetrically in the usual way, from the amount of cupric oxide reduced from Fehling's solution. It yielded 2 75 per cent.

(To be continued).

ON THE

COMPONENTS OF THE RARE EARTHS GIVING ABSORPTION-SPECTRA.

By GERHARD KRÜSS and L. F. NILSON.

(Continued from p. 87).

7. *Euxenite of Hitterö and of Arendal.*

DURING former researches on ytterbia, the atomic weight of ytterbium, and on scandium, several kilos. of

IX. *Holmium Material.*

Observed position of maximum darkness. Positi. n of Telescope-drum.	Wave-length observed.	Wave-lengths formerly observed.	For.	Intensities of bands.
2353	729·0	728·3	Di	Rather strong.
2455	654·7	654·7	Er	Faint, broad.
2480	640·6	640·4	X	Strong.
2682	542·6	542·6	X	Fine and clear.
2688	539·0	—	(?)	Faint but distinct.
2698	535·5	536·3	X	Strong.
2740	523·6	523·1	Er	Faint, distinct.
2747	521·6	521·5	Di	Faint, broad.
2872	485·9	485 5	X	Strong.
2887	482·5	482·0	Di	Scarcely visible.
2920	474·9	474·5	X	Rather strong.
2943	469·4	469·0	Di	Very faint, but definite.
3030	452·0	453—449	X	Extremely strong.
3163	428·9	428·5	X	Faint.
3240	417·3	416·7	Sm	Very strong.

X. *a. Euxenite from Hitterö.*

Position of maximum darkness.		Wave-lengths formerly observed.	For.	Intensity of Bands in Spectra of Fractions.					
Position of Telescope-drum.	Wave-length.			I.	II.	III.	IV.	V. and VI.	VII.
2353	729·0	728·3	Di	Strong.	Rather strong.	Rather strong.	Rather strong.	Rather strong.	Rather faint.
2413	684·4	684·0	Tm	Faint.	Faint.	Faint.	Faint.	Faint.	Faint.
2419	680·0	679·4	Di	Strong.	Rather faint.	Faint.	Very faint.	—	—
2456	654·2	654·7	Er	Extremely faint.	Very faint.	Very faint.	Extremely faint.	Extremely faint.	Scarce visible.
2480	640·6	640·4	X	—	—	—	Very faint.	Faint.	Faint.
2505	621·1	621·1	Di	Faint.	Very faint.	Very faint.	—	—	—
2568	591·5	591·5	Di	Rather faint.	Rather faint	Faint.	Extremely faint.	—	—
2595	579·6	579·2	Di	Very strong.	Very strong.	Very strong.	Strong.	Strong.	Faint.
2604	575·8	575·4	Di	Very strong.	Strong.	Strong.	Faint.	Faint.	Very faint.
2682	542·6	542·6	X	Extremely faint.	Extremely faint.	Very faint.	Very faint.	Very faint.	Extremely faint.
2698	535·5	536·3	X	Rather faint.	Rather faint.	Faint.	Faint.	Very faint.	Very faint.
2747	536·6	—	?	—	—	—	Very faint.	Faint.	Rather strong.
2740	523·6	523·1	Er	Extremely strong.	Strong.	Strong.	Strong.	Strong.	Rather strong.
2747	521·6	521·5	Di	Strong.	Rather strong.	Rather strong.	Faint.	Faint.	Very faint.
2780	512·5	512·2	Di	Very strong.	Rather strong.	Rather faint.	Faint.	Very faint.	Scarce visible.
2872	485·9	485·5	X	—	—	—	—	Faint.	Faint.
2887	482·5	482·0	Di	Very strong.	Rather strong.	Rather faint.	Faint.	Very faint.	Very faint.
2911	477·0	477·7	Sm	Strong.	Rather strong.	Rather strong.	Faint.	Very faint.	Very faint.
2920	474·9	474·5	X	—	—	—	—	Faint.	Faint.
2943	469·4	469·0	Di	Strong.	Rather faint.	Extremely faint.	Very faint.	Very faint.	Very faint.
2974	462·3	463·2	Sm	Strong.	Strong.	Strong.	Strong.	Strong.	Rather strong.
3030	452·0	453—449	X	—	—	Strong.	Very strong.	Very strong.	Very strong.
3076	444·2	444·7	Di	Very strong.	Strong.	Faint.	Very faint.	—	—
3163	428·9	428·5	X	Strong.	Rather strong.	Rather strong.	Rather faint.	Faint.	Faint.
3240	417·3	416·7	Sm	Very strong.	Very strong.	Very strong.	Very strong.	Strong.	Rather strong.

earths from the euxenites of Hitterö and Arendal had been worked up, and these were submitted to a close spectroscopic examination. The mixed nitrates were separated by the known method of partial decomposition by heat. Each nitrate solution characterised as a fraction or series in the following Tables resulted from 6 to 7 separate decompositions.

In connection herewith there was examined a material rich in holmium, obtained by heating fractions 5—43 of the euxenite earths from Hitterö. (See Table IX.)

The hitherto unidentified line $\lambda=539{\cdot}0$ was observed in the spectrum of this holmium material; elsewhere it has been detected only in thorite and in the Brevig Wœhlerite. (See Tables X. and XI.)

(To be continued).

CHEMICAL INTEGRATION.*

By T. STERRY HUNT.

§ 1. The process of chemical union or combination has been defined as interpenetration and as identification, by Kant and by Hegel, and more recently, by the present writer, as integration; all changes in matter, as Herbert Spencer has well said, being resolvable into integration and disintegration. This process may take place either among unlike or like species, being in the latter case a homogeneous integration, constituting what is called polymerisation, while depolymerisation is a homogeneous disintegration. These two forms of the chemical process, as was defined in 1853, are respectively metamorphoses by condensation and by expansion, and were by the writer then included under the name of *chemical metamorphosis*. The relations of these homogeneous changes to heterogeneous integration and heterogeneous disintegration, which give rise to species differing in centesimal composition from the parents, and constitute what was at the same time distinguished as *chemical metagenesis*, are obvious.

§ 2. It was further shown that heterogeneous integration followed by heterogeneous disintegration or dissociation, giving rise to two species unlike the parents, constitutes what is called double decomposition, and that a similar heterogeneous integration, followed by a homogeneous dissociation, is seen when chlorine and hydrogen gases by their union give rise to chlorhydric gas, without change of volume, the condensation involved in the process of integration being immediately followed by an expansion of similar amount. The law of chemical condensation and chemical expansion being universal, there is theoretically no limit to either of these processes. Such homogeneous expansion or dissociation, it is known, takes place in elemental gaseous species, as when the vapours of sulphur and iodine are exposed to elevated temperatures, as well as in the vapours of compound species like nitric peroxide, acetic acid, and turpentine oil.

§ 3. The chemical species, to those agencies which do not effect its disintegration, is a complete entity or integer. This, in the case of homogeneous integration in gases and vapours, is generated by the condensation into a single volume of two or more volumes of a less dense species. The designation of polymers given to such condensed species, implying that they are made up of many parts, carries with it the notion of building by additions, and thus of complexity rather than of integrity: it is therefore rejected.

We assume hydrogen as the type of the normal integer, and the weight of two portions of this element ($H_2=2{\cdot}0$) being the unit, the weight of a like volume of any other gas or vapour is its equivalent weight; that is to say, the weight of a volume equal to H_2. This, in the language of the atomic hypothesis, is its molecular

* Read before the National Academy of Sciences at Washington, April 19, 1887.

a. Euxenite from Hitterö (continued).

Intensity of Bands in Spectra of Fractions.

VIII.	IX.	X. and XI.	XII—XVI.	XVII.—XXIV.	XXV.—XXVIII.	XXIX.—XXXIII.	XXXIV.—XLIII.
Faint.	Very faint.	—	—	—	—	—	—
Faint.	Faint.	Very faint.	Very faint.	—	—	—	—
—	—	—	—	—	—	—	—
Very faint.	Very faint.	Very faint.	Very faint.	Extremely faint.	Extremely faint.	Extremely faint.	Extremely faint.
Rather strong.	Rather strong.	Rather strong.	Rather strong.	Rather strong.	Rather strong.	Rather strong.	Rather strong.
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
Faint.	—	—	—	—	—	—	—
Very faint.	—	—	—	—	—	—	—
Extremely faint.	Extremely faint.	Scarce visible.	Scarce visible.	Scarce visible.	Scarce visible.	Scarce visible.	Scarce visible.
Very faint.	Very faint.	Extremely faint.	Extremely faint.	Extremely faint.	Extremely faint.	Scarce visible.	Scarce visible.
Rather strong.	Rather strong.	Rather strong.	Stronger than X line $\lambda=640{\cdot}4$.	Stronger than $\lambda=640{\cdot}4$.	stronger than $\lambda=640{\cdot}4$.	Strong.	Strong.
Rather strong.	Rather strong.	Rather faint.	Faint.	Very faint.	Very faint.	Extremely faint.	Extremely faint.
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
Rather strong.	As VIII.	As VIII.	As VIII.	As VIII.	As VIII.	Strong.	Strong.
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
Rather strong.	Rather strong.	Rather strong.	Fainter than X line $\lambda=485{\cdot}5$.	Rather faint.	Rather faint.	Rather strong, fainter than X line $\lambda=485{\cdot}5$.	Fainter than $\lambda=485{\cdot}5$
Extremely faint.	Extremely faint.	Extremely faint.	Extremely faint.	Very faint.	Very faint.	Extremely faint.	Extremely faint.
Faint.	Scarce visible.	—	—	—	—	—	—
Very strong.	Extremely strong.	Extremely strong.	Extremely strong.	Extremely strong.	Extremely strong.	Extremely strong.	Extremely strong.
—	—	—	—	—	—	—	—
Very faint.	Very faint.	Extremely faint.	Extremely faint.	Extremely faint.	Scarce visible.	Scarce visible.	Extremely faint.
Rather strong.	Rather faint.	Faint.	Very faint.	Very faint.	Very faint.	Very faint.	Very faint.

weight, the so-called atomic weights being the smallest combining weights of the elemental species, compared with H = 1·0.

§ 4. The normal integers of oxygen, hydrogen, and chlorine, and of bromine and iodine vapours, are thus double or dyad integers, while ozone and the vapour of selenium below 800° are triple or triad, and that of sulphur vapour below 550° is sextuple or hexad; all of these, however, at higher temperatures assuming the densities of the normal or dyad integers. The quadruple integers of phosphorus and arsenic vapours, there is reason to believe, undergo a like change; while the double integer of iodine at about 1500° becomes, as is well known, a single or monad integer, a result which at the highest temperatures of experiment is already partially attained for bromine and chlorine; the vapours of mercury and cadmium being known to us only in this condition of monad integers. Such a state, from analogy, we may conceive would be attained under favourable conditions of temperature and pressure for the vapours of all known elements, and may, as the writer has elsewhere suggested, actually take place, for many species, in the electric arc; while, as he was the first to point out, in 1867, a still further dissociation, yielding unknown and still more elemental forms, probably appears in solar and nebulous matter.

The subject of homogeneous disintegration by heat is further illustrated by the vapour of nitric peroxide, of acetic acid, of paraldehyd, and of turpentine oil. These integers of varying densities, and of varying equivalent weights, alike of so-called elements and of compounds having a similar centesimal composition, may be conveniently designated higher and lower integers; the terms implying at the same time higher and lower specific gravities, and higher and lower equivalent or integral weights, since the density or specific gravity, as is well known, varies as the equivalent weight in the case of gases and vapours.

§ 5. A similar direct relation between equivalent weight and specific gravity in liquids and in solids was first indicated by the writer in 1848, and was again urged in 1853.* It was further insisted upon in a communication to the French Academy of Sciences in 1855, when after saying that "Since the chemical combination of two bodies is to be regarded as an interpenetration of masses, and not as a juxtaposition of molecules, the atomic hypothesis is not necessary for the explanation of the law of equivalent weights," it was added—"Their densities thus furnish us a means of fixing the equivalent weights of gases, and of bodies which volatilise without decomposition, and it remains to be determined if some law as simple as that of Gay-Lussac would not permit us to fix by similar means the equivalents of solids and non-volatile bodies."† The further development of this problem in subsequent years we have discussed at length in the volume cited above.

§ 6. In accordance with this conception the writer, in 1853, spoke of "that mode of metamorphosis which constitutes polymerism." The conception of polymerism or homogeneous integration as of universal application in chemistry was further insisted upon in 1867, when it was asserted that "the gas or vapour of a volatile body constitutes a species distinct from the same body in its liquid or solid state, she chemical formula of the latter being some multiple of the first; and the liquid and solid spe-

* See the author's lately published volume, "A New Basis for Chemistry," pp. 11, 12, and 38, 39, wherein the citations given below in this paragraph were, by inadvertence, omitted

† "Sur les Volumes Atomiques," *Comptes Rendus de l'Académie des Sciences*, xli., 77—81. "Puisque la combinaison chimique de deux corps doit être regardée comme une interpénétration des masses et non pas une juxtaposition des molécules, l'hypothèse atomique n'est pas nécessaire pour expliquer la loi des poids équivalents." . . . "Les densités nous fournissent ainsi un moyen de fixer les poids équivalents des gaz et des corps qui sont vaporizables sans decomposition, et il restait à determiner si quelque loi aussi simple que celle de Gay-Lussac ne nous permettrait pas de fixer par un moyen semblable les équivalents des corps solids et non volatiles."

cies often [probably always] constitute two distinct species of different equivalent weights." It was at the same time further asserted of the liquid and solid alcohols, acids, ethers, and glycerids, that "these non-gaseous species are generated by the chemical union or identification [integration] of a number of volumes or equivalents of the gaseous species, which number varies inversely as the density of the species."* From this it follows that all condensation of gases and vapours by cold or pressure, and all fusion, solidification, and vaporisation are chemical metamorphoses. The law of volumes, hitherto applied only to gases and vapours, extends to all solid and liquid species, and is a universal law.

§ 7. The identification of the processes of vaporisation and condensation of vapours with chemical change is in accordance with the views enunciated by Henri Sainte-Claire Deville, in his researches on dissociation, between 1857 and 1865.† These views are well resumed in his final statement, in 1873, that Isambert, in his studies of the compounds of ammonia with chlorides, "not only demonstrates the analogy between the phenomena of dissociation and of vaporisation, but establishes their complete parallelism." Hence, in the opinion of Deville, "There is, according to these ideas, no essential difference between physical phenomena and chemical phenomena, or rather the passage from the one to the other is continuous."‡ It may be said, in comment upon this remarkable statement, that until the true nature of the processes of volatilisation and vaporous condensation had been established those chemical phenomena marked by changes of state had been wrongly regarded as physical (or dynamical) phenomena. By "changes of state" are here meant all changes between the conditions of gas, liquid and solid, as also the transformations of these, which are always marked by alterations in density, as well as in other physical characters. Illustrations of these changes are familiar alike in simple and in compound species.‖

§ 8. It follows from these considerations that if the law of volumes, recognised by Gay-Lussac in the changes of gases and vapours, is to be extended, as we have maintained, to their condensation into liquids and solids, so that for these, as for gases, the specific gravity is a function of the equivalent weight, we are forced to the conclusion that the equivalent or integral weights of liquids and solids are much more elevated than has been hitherto supposed. This the writer taught from 1853 up to 1885, although he had not in those years arrived at the simple means of fixing the value of these weights, subsequently set forth in 1886.§

These elevated equivalent weights furnish illustrations of the great principle of progressive series in chemistry, which, first recognised in 1842, by James Schiel, in the formula of related bodies differing by $n(CH_2)$, and in that form adopted by Charles Gerhardt in 1844, was in 1853 generalised by the present writer, and regarded as a principle of universal application. As then pointed out, progressive series in chemistry may be included under two heads,—those in which the first term is the same as the common difference, as seen in polymerisation or homogeneous integration, and those in which it is unlike the common difference. It was at that time asserted that there are progressive series,—having homologous relations between their members,—differing not only by $n(CH_2)$, but by $n(OH_2)$, by $n(OM)$, and by $n(SM)$, as well as by $n(CMO_3)$.

The subject was further pursued in a communication to the French Academy of Sciences in 1855, when it was said—"These homologous relations, far from being limited to carbon compounds, are but examples of that numeric harmony seen by Laurent, and recognised by Dumas in the equivalents of the elements, which will become for chemistry a principle as wide in its application as those of atomic weights and volumes." Of the writer's studies of the latter, it was further said by him, in 1855, that they were undertaken "in the hope of giving to mineral chemistry something of that exactitude which organic chemistry already possesses."*

(To be continued).

NOTICES OF BOOKS.

Food Adulteration and its Detection: With Photomicrographical Plates and a Bibliographical Appendix. By JESSE P. BATTERSHALL, Ph.D., F.C.S., Chemist, U.S. Laboratory. New York and London: E. and F. N. Spon.

WE have here a compendious manual, in which the chief sophistications of food actually practised are described, and satisfactory instructions for their detection are communicated. Substances not ranking as food are not included. The author is fully aware of the difficulty of dealing with adulteration by law and of securing a conviction when guilty knowledge has to be proved. He admits that manufacturers and dealers are often forced into adulteration by the necessities of trade competition, and that as a rule an honest dealer cannot compete with a dishonest one. But the obvious remedy is such a diligent execution of the law that the dishonest trader may find his manipulations unprofitable. Still more important would be, if it can be effected, the creation of a public opinion which will place the adulterating tradesman on the same level as the pickpocket.

After these preliminary remarks the author gives a brief history of adulteration, an art which may certainly claim a high antiquity. We learn that in the fifteenth century a wine-sophisticator of Biebrich was sentenced to drink six bottles of his own stock, and that he did not survive the experiment. English statistics here quoted are not very encouraging. In 1875-6, out of the samples analysed under the provisions of the Sale of Food and Drugs Act, the percentage of adulterated samples was 18·10, and in 1883 16·4. What our author does not mention is that in this country public interest in the working of the Act has by no means increased.

In the section on tea it is stated that according to recent reports of American consuls in China and Japan the

* *American Journal of Science*, xliii., 205; also the writer's "Chemical and Geological Essays," 456, and "A New Basis for Chemistry," 41, 42.

† "A New Basis for Chemistry," 133—137.

‡ Report by Deville on a Memoir by Troost and Hautefeuille. "Sur les Transformations Isomériques et Allotropiques"; *Comptes Rendus de l'Académie des Sciences* (1873), lxxvi. "Isambert . . . non seulement demontre l'analogie entre les phenomènes de dissociation et de vaporization, mais en établit le parallelisme complet." . . . Il n'y a aucune différence, d'après ces idées, entre les phenomènes physiques et les phenomènes chimiques, ou plutot le passage des uns aux autres se fait par des variations continues."—Deville, *loco citato*.

‖ Of phosphorus, which affords perhaps the most instructive example of these changes, there are known (1) the vaporous species, which according to Victor Meyer gives indication of conversion into a more elemental species at very high temperatures; (2) liquid phosphorus which boils at about 279°,—when it has a density of 1·5285,—and may, under proper condition, be cooled to 20° or even to 0°, but below 44° is readily changed, with rise of temperature, into the solid, transparent, colourless crystalline species (3), which is luminous in the air, soluble, poisonous, a non-conductor of electr city, having at 40° a density of 1·806. This is converted by sunlight, by the action of iodine, by a temperature of 230°, or more rapidly, with evolution of heat from the condensation, when exposed to the temperature of boiling sulphur [450°] into (4) the amorphous red species, insoluble, non-luminous, and non-poisonous, with a density of about 2·10. This species volatilises *in vacuo*, without fusion, at 550°, and is re-deposited in red crystals, which are perhaps identical with the red crystallised metalloidal species (5) got by melting lead with phosphorus under pressure, which has a density of 2·34 at 15°, and is a conductor of electricity. The forms of red phosphorus with intermediate densities are possibly mixtures of the last two species.

§ See "A New Basis for Chemistry," 100, 111.

* *Comptes Rendus de l'Acad. des Sciences*, xii., 77-81: sur les Volumes Atomiques.—"Ces rapports d'homologie, loin d'etre limités aux composés de carbone, ne sont que des examples de cette harmonie numérique que voyait déjà Laurent, que Dumas a reconnue dans les équivalents des eléments, et qui deviendrait pour la chimie un principe d'une application aussi large que ceux des poids et des volumes atomiques." . . . . "Dans l'espoir de donner à la chimie minérale quelque chose de cette exactitude que possède déjà la chimie organique." *Loco citato*.

addition of spurious leaves to tea is now rare in those countries. The remark is made that, contrary to popular belief, there is no invariable relation between the quality of tea and its proportion of theine.

Under coffee we are told that letters patent have actually been issued for the manufacture of a fictitious "coffee-bean," containing no coffee. It is not stated what country has thus committed itself. One of the methods given for the examination of ground coffee is the colour-test, proposed by Leebody in the CHEMICAL NEWS, vol. xxx. The tinctorial power of chicory is three times as great as that of coffee. Of 151 samples of ground coffee recently purchased at random and tested by various American chemists, 45·7 per cent were found to be adulterated.

In discussing milk the author seems to defend the lactometer, the sin of which is not so much that it may condemn a sample unusually rich in cream as that it may absolve one skimmed and then watered. In comparing the milk of various mammals he uses the word "canine" as a substantive, though he does not name a mare an "equine" nor an ewe an "ovine."

Under butter due attention is given to the rather difficult problem of distinguishing butter from oleomargarine. Dr. Thomas Taylor some little time ago considered that when the samples are viewed by polarised light "the presence of peculiar globular crystals and the black cross commonly termed St. Andrew's cross, indicate genuine butter. In the annexed photomicrograph, however, we see, as the author points out, the St. Andrew's cross in oleomargarine. Dr. Taylor has more recently proposed another optical test. Butter, when observed by polarised light through a selenite, exhibits a uniform tint, whilst other fats observed in the same manner show prismatic colours. As regards oleomargarine, the author—very justly in our opinion—contends that it is to be condemned only when sold as butter, but not otherwise. It is certainly less digestible than genuine butter, but according to experiments here cited, only in the proportion of 1·6 per cent. The most digestible fat is cod-liver oil, then follows natural butter, then lard oil, and next the oleomargarine of commerce.

We are glad to see Mr. Battershall protesting against the common notion that water may be purified by freezing. Numerous experiments which we instituted fifteen years ago convinced us that this belief is no better than a superstition.

Amongst miscellanea we find mention of a spurious brand of red currant jelly, manufactured in France, and now finding its way into America, and doubtless into Britain also. It is prepared from a Japanese sea-weed, with the addition of glucose, tartaric acid, and an artificial "essence of currants," and coloured with cochineal and *Althea roseata*. This compound is sold at about 2½d. per lb. The flour used for maccaroni is sometimes delicately tinted with chrome-yellow.

Certain manufacturers of soda-water in New York derive their supply of water from artesian wells on their own premises, and very likely to contain sewage contamination.

Whilst regretting that we can no further carry our survey of this interesting work, we have pleasure in recommending it to chemists who practise food analysis, as well as to public health authorities.

CORRESPONDENCE.

COLOURED LIGHTS.

To the Editor of the Chemical News.

SIR,—In a "Report to the Right Honourable the Secretary of State for the Home Department, on the Circumstances attending an Explosion of Fireworks which occurred at Messrs. Dyer and Robson's Factory in Greenwich Marshes, on the 11th June, 1887, by H.M. Chief Inspector of Explosives," the following is given as the composition employed for coloured lights in the Royal Laboratory at Woolwich (page 9):—

Chlorate of potassium	2 lbs.
Nitrate of barium	5 lbs.
Sulphur..	1 lb. 8 ozs.
Calomel	1 lb.
Charcoal	3 ozs.
Shellac	2 ozs.

Will you kindly allow me space to ask if any of your readers can inform me for what chemical reason the expensive calomel is employed? I have examined all the prescriptions for fireworks within my reach, but neither calomel nor any other compound of mercury is mentioned.—I am, &c.,

PRACTICAL CHEMIST.

September, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 6, August 8, 1887.

New Fluorescences with Well-defined Spectral Rays.—Lecoq de Boisbaudran.—Observations on the fluorescences of the aluminium "activated" by the presence of the earths $Z\alpha$ and $Z\beta$. For alumina activated with the former of these earths an energetic ignition greatly intensifies the fluorescence, transforming, at the same time, the broad nebulous bands into corresponding groups formed of distinct rays. At the same time the spectral groups are displaced towards the red. The author announces also that he has obtained very fine linear fluorescences by strongly igniting alumina containing a little didymium or praseodymium.

No. 7, August 16, 1887.

Novel Fluorescences with Well-defined Spectral Rays.—Lecoq de Boisbaudran.—The author has experimented on alumina mixed with the earth, to which he gives the name $Z\beta_2O_3$. He has also examined the fluorescences of calcined alumina containing admixtures of various oxides. With specimens rich in erbium, dysprosium, thulium, and gadolinium he has obtained spectra with rays, which will be described in a future paper. Cerium gives a fine blue fluorescence without rays. Lanthanum and yttrium did not show any fluorescence deserving notice. Ytterbium gave blue fluorescence and four small bands. Uranium does not render aluminium fluorescent.

Dissemination of the Bacillus of Tuberculosis by Flies.—MM. Spillman and Haushalter.—The authors have noticed how common flies haunt the beds of consumptive patients in hospitals, and suck up the expectorated matter. Some of these flies having been caught, and placed under glass bells, their excrements were found to contain numbers of the bacillus of Koch.

Bulletin de la Société Chimique de Paris. Vol. xlvii., No. 9, May 5, 1887.

Sweetening of Musts, Ciders, and Perries, and the Manufacture of Sugar Wines.—D. Klein and E. Fréchou.—The authors have determined the quantity of sugar to be added to grapes or to a marc to obtain a given alcoholic strength. They have also studied the means for effecting the comple inversion of the sugar added.

On Isodulcite.—Bohuslaw Rayman.—The author finds that isodulcite is a homologue of arabinose, and belongs to a new group, that of the glucoses corresponding to the quintivalent alcohols.

Action of Nitric Acid upon the Solubility of Alkaline Nitrates.—R. Engel.—Even for sodium nitrate, which has no known corresponding acid salt, the action of nitric acid is of a purely physical order only when the quantity added is inconsiderable.

Reply to M. Friedheim's Critique on the Author's Process for Titrating Sulphur in Sulphites decomposable by Hydrochloric Acid.—F. Weil.—The author's process was noticed under the *Comptes Rendus*, vol. cii., p. 1487. He maintains that the process always gives very exact and concordant results, and that its execution is easy, rapid, and convenient.

Reply to the Remarks of M. l'Abbé Godefroy on M. Roussan's Process for the Purification of Phlegms.—L. Naudin.—The writer does not find this process satisfactory.

On Anemonine.—M. Hanriot.—The author has studied the action of anemonine with reducing agents and with bromine. He obtains hydroanemonine by the action of nascent hydrogen upon bromanemonine.

Synthetic Researches on Certain Derivatives of Diphenyl.—P. Adam.—Not adapted for useful abstraction.

MISCELLANEOUS.

Schools of Chemistry, &c.—The following information was received too late for insertion in our Student's Number:—

King's College, London.—A special course of Evening University Lectures will be given on "The Manufacture and Uses of Iron and Steel," by Mr. W. G. McMillan, F.C.S., commencing on Thursday, October 13. The first lecture will be free. Fee, £1 1s., or 10s. 6d. for Matriculated Students of any department of the College.

Leeds School of Science.—Lecturers on Chemistry and Metallurgy: J. Wertheimer, B.A., B.Sc., F.C.S., E. Rawlins, F.C.S., H. Eccles, F.C.S., and F. Matthewman. The Chemical Courses provide for students entering for the Matriculation, Intermediate, and Final B.Sc. examinations, London, and for the Pharmaceutical Society's examinations. Ladies are admitted to all the classes. Prospectuses and full information as to fees, &c., may be obtained of the Registrar, Mr. J. O. Dayson, Leeds School of Science, Cookridge Street, Leeds.

The Technical School, Manchester.—Lecturers on Chemistry, Physics, and Chemical Technology, H. Lloyd Snape, B.Sc. (Lond.), E. L. Rhead, Ernest Bentz, G. H. Hurst. The day classes commenced on August 29th, 1886, and the evening classes will commence on September 26th, 1887. First year: Lectures upon the Chemistry of the Non-metallic Elements, and of the more commonly-occurring Metals. Second year: Lectures upon the Purer Metals, Organic Chemistry, and Chemical Philosophy. In the Laboratories instruction is given in Qualitative and Quantitative Analysis. Practical classes are also held in the Metallurgical and Dyeing Laboratories. Technical Students have opportunity to attend, and are urged to join classes in mechanical drawing, and to take practical manual exercise in wood and metal working. Special practical work in any branch of Chemical Technology, or in preparation for University Examinations, will be arranged to suit individual Students. The evening Courses of instruction are especially designed to meet the wants of those already engaged in various industries. A syllabus, containing full particulars as to hours, fees, &c., may be obtained from Mr. J. H. Reynolds, The Technical School, Manchester.

Recreative Evening School Association.—President, Princess Louise; Treasurer, Cyril Flower, Esq., M.P.; Secretary, J. E. Flower, M.A. Office, 37, Norfolk St., Strand. *Object.*—To stimulate a healthy desire for knowledge on the part of boys and girls outside the range of the School Board, by presenting scientific knowledge in an attractive and popular style in evening classes, conducted by honorary teachers or lecturers in Board or other schools. Classes were conducted by this Association last winter in some 80 or 100 Board Schools, and the programme of next winter's work is on a much more extended scale. When one considers that 80,000 boys and girls leave our Board Schools annually between the ages of 14 and 18, one can readily understand there to be a want which the Association is manfully trying to supply, viz., continuance of education and the creation of a desire for scientific knowledge. The lines upon which the Association is working seem to us to be sound, inasmuch as they popularise Science rather than soar above the heads of their classes, for by means of lantern demonstrations and simple experiments they render as attractive as possible the subjects treated. The Syllabus of work for the coming season embraces, amongst others, the following subjects:—

A. *Chemistry and Physics.*—I. Chemistry (Inorganic). II. Physics.

(1) Elementary Mechanics and Pneumatics; (2) Elementary physical properties of air and water; (3) Sound; (4) Light; (5) Heat; (6) Magnetism and Electricity; (7) Physical Astronomy.

B. *Biology.*

(1) Elements of Animal Physiology; (2) Elements of Vegetable Physiology; (3) Structure of leading forms of animal life; (4) Structure of leading forms of vegetable life.

C. *Geology and Physiography.*

(1) Physical Geography; (2) Stratigraphical Geology; (3) Palæontology.

The following gentlemen form the Science Committee of this Association, and prepare popular Science lectures, illustrated with some fifty slides for each subject, which, together with suitable lanterns and all necessary apparatus, are placed in the hands of volunteer lecturers, who thus help in carrying on a noble educational work:—H. G. Rawson, Esq. (Chairman); W. Lant Carpenter, Esq.; C. Dexter Barker, Esq.; Prof. F. Jeffrey Bell; F. W. Rudler, Esq.; J. J. Harris Teal, Esq. We are particularly requested by the Science Committee to ask our readers who feel inclined to help to apply for further particulars to the Secretary, J. E. Flower, Esq., 37, Norfolk Street, Strand, W.C. PS.—All expenses are borne by the Association.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Vapour Densities.—Would any kind reader be good enough to explain without mathematical formulæ Victor Meyer's method for the determination of vapour density, and oblige a Poor Student.

TO CORRESPONDENTS.

J.H.E.N.—(1) "Laboratory Guide," by A. H. Church, Van Voorst, 2nd Edit., is the best work we know on agricultural analysis, soils, &c. (2) We know of no one work which gives the results of the analyses of various farm plants and seeds, garden seeds and bulbs. The information you require is scattered through a variety of books and journals.

Bertha Körter.—We regret we are unable to give the desired information on the healing properties of gold.

THE CHEMICAL NEWS.

Vol. LVI. No. 1453.

THE RELATION OF SCIENCE TO THE STATE.

II.

Having endeavoured to explain what Science really is, or, at any rate, to define the term as we are about to use it, we come to our real object.

It must be known to all our readers, and to thousands more of intelligent and cultivated persons, that there is considerable dissatisfaction with the present position and prospects of Science in this country. Every reader of the daily papers must have come upon utterances to this effect, delivered by men of influence and position. Now it may be asked whether, in face of what might almost be called an agitation, there is any necessity for us to take up the question? We reply that there is such necessity. It may easily happen that after much talk—as we read in the reports of Parliamentary debates—"the subject then dropped." Or it may occur that we take steps which shall lead us in the wrong direction, and which may have to be re traced not without difficulty. It is therefore important that scientific men should at any rate compare notes and come to an understanding among themselves, and should then seek to impress the outside public—and more especially statesmen—with a true view of the case.

One satisfactory feature in the present excitement must be thankfully recognised,—*i.e.*, the growing conviction that a high standing in Science, especially in chemistry and physics, has in these days become essential to national prosperity, security, and progress. The times are past when mere energy, industry, perseverance, "pluck," were sufficient to determine success in the rivalry either between individuals or between nations. We do not in the least undervalue certain moral attributes, even though we see some countries making startling advances in their absence. We fully recognise the importance of physical superiority, health, strength, and endurance. But the question which nation shall survive as the "fittest" is after all to be determined at least as much by its intellectual supremacy. Here we must draw a further distinction: high natural intelligence is not all, it is merely a foundation; intellectual culture is not all, it may not be culture of the right kind. Historians, ethicists, musicians, orators, parliamentary or forensic,—how numerous and able soever,—may, indeed, win for themselves great *kudos* along with other more tangible advantages; but they do marvellously little to increase the resources of their country, or to raise its position in the eyes of foreigners.

It may safely be said that the arts, alike of peace and of war, are turning more and more on progress in physics and chemistry. We have, in our first paper on this subject, drawn a distinction between Science, in the strict sense of the term, and what is called "Applied Science." But without original research culminating in discovery there will be nothing to apply. Discovery is the seed (and a seed which often brings forth fruit a thousandfold) of which inventions and applications are the harvest. It stands to reason that the nation which takes the lead in discoveries will be the richest also in their "practical applications." It will at all events have the monopoly of such applications for the first few years, and this is almost everything. By the time that a newly invented industrial process has reached foreign countries the product will have fallen in price; "the cream," as men of business often put it, "has been taken off," and it is generally superseded by something newer, if not better. Surely this has been fully illustrated in the manufacture of the coal-tar colours. For the most part they have been discovered not by hap-hazard experimentation, but in consequence of speculative researches into the constitution of the coal-tar product. Their manufacture has all along flourished chiefly in the countries where such researches were made and where the discoveries were effected, that is, at first in England and France, but more recently in Germany and Switzerland.

That certain circumstances, in addition to the comparative neglect of chemical research, have contributed to the decline of the chemical arts in the United Kingdom is perfectly true. Such, *e.g.*, is the unwisdom of our patent system which allows an alien to hold a British patent, whilst refusing to work it or allow it to be worked on British ground. Such, too, is the fact that articles made abroad in infringement of a British patent can be introduced safely into this country if consigned directly to the consumer. But this is beside our immediate question.

Surely, viewing the history of the coal-tar products, we may venture to draw the conclusion that flourishing scientific research has become the necessary preliminary to superiority in industry, and that the nation which takes the lead in the one must ultimately take the lead also in the other.

We must further contend that pre-eminence in Science is an essential element of national *prestige*. We shall not enter into any hair-splitting disquisitions on the etymology of the word we have just used. Practical men understand by it that reputation which is to a community what unimpeached credit is to a merchant.

Now if we examine the causes which have led to the recent wonderful extension of German commerce—gained often at our expense—we shall see that this very intellectual *prestige* plays no small part. For instance, numbers of Japanese students of medicine resort to the German universities. When they return to their own country, and enter upon their professional career, they not unnaturally retain a preference for German pharmaceutical preparations. This leads to an increased demand in Japan for German chemicals. This commercial benefit to Germany is distinctly due to the high reputation of the German universities. A similar state of things prevails more or less elsewhere.

Again, we cannot help noticing the number of German scientific men who obtain official positions in foreign countries, such as the South American republics, Brazil, and even in the British Colonies. We find such German *savants* in charge of museums, botanical gardens, observatories. We see them appointed to professorships in universities, mining schools, and hospitals. Such men naturally acquire influence, and not having, like certain Englishmen, abjured patriotism, they use it on behalf of German interests. Do they require apparatus or materials of any kind, they recommend that these should be obtained from the Fatherland. Are they consulted, whether by public authorities or private persons, on industrial or sanitary questions, they still keep the advancement of German commerce in view.

Here, again, we see how the *prestige* of the German universities, as scientific and technical training schools, tells even in a money point of view.

The number and the success of German scientific explorers in those parts of the world not as yet fully known must not be overlooked. These men, however devoted they may be to the advancement of Science, do not overlook the advancement of German interests.

Other European countries, also, according to their opportunities, adopt a similar line of policy and foster Science, even in the most abstract departments, for the reputation and the benefits which she confers. And they have their reward.

University College, London.—Mr. Cassal has resigned the appointment of Demonstrator in the Hygienic Laboratory at University College, London.

CHEMICAL INTEGRATION.*

By T. STERRY HUNT.

Concluded from p. 138.

§ 9. In a later note, on the "Relations between certain Bodies differing by H_2 and O_2," presented to the same Academy in 1855, after recalling the above conclusions as to homologous series, it was maintained that similar relations may exist between bodies differing in their proportions of oxygen or of hydrogen. In support of this thesis, as regards oxygen, were then compared alike, chemically and crystallographically, malic and tartaric acids, chlorates and perchlorates, sulphates, carbonates and sulphatocarbonates. As regards hydrogen, the compound ammonias, $NH_3+n(CH_2)$, were compared with the analogous base piperidine, belonging to a series $NH+n(CH_2)$, and with arsine or methyl arsenid, $AsH+CH_2$. These facts and other considerations, it was then argued, "lead us to admit an intimate relation between bodies differing by H_2," as well as by $O_2(O=8)$.†

§ 10. A further illustration of this extension of the conception of progressive series was soon afterwards afforded by the studies of J. P. Cooke on the crystallised alloys of zinc and antimony, which, with similar crystalline forms, present considerable variations in the proportions of their constituents, leading him to the conclusion that "zinc and antimony are capable of uniting in other proportions than those of their chemical equivalents, or, in other words, that the law of denfiite proportions is not so absolute as has been hitherto supposed."‡ In commenting on these results, as they had been set forth by Cooke in 1860, it was said by the writer in 1874:—"These alloys of varying composition are to be regarded in part as examples of a progressive series of isomorphous compounds of antimony and zinc, of high equivalent, differing from each other nZn_2,—and in part doubtless as crystalline mixtures of these isomorphous homologous species. The principle embodied in the conception advanced by Prof. Cooke, and rightly regarded by him as of great importance to a correct science of mineralogy, he has named allomerism. It is evidently a case of homologous and isomorphous relations between members of a progressive series,—a general principle upon which I have insisted throughout the pages of this paper [one in the *Comptes Rendus* of the French Academy of Sciences for June 29, 1863, there reprinted], and which includes the polymeric isomorphism of Scheerer."§

§ 11. If now, as was argued in 1853-1855, the equivalent or integral weights of liquid and solid species are represented by very large numbers (which, as was subsequently shown, are multiples by many thousands of that of hydrogen), and if, as was then further maintained, there are found among such species bodies belonging to progressive series having as a common difference not only CH_2, OH_2, and OM, but M_2, H_2, and O, it becomes apparent that the chemical formulas of bodies so related may present ratios much less simple than those hitherto generally admitted. If, in fact, the relations perceived in surbasic salts, such as the so-called subnitrates and subsulphates, which differ among themselves by $n(MO)$ be extended to other compounds, and if oxides with elevated formulas differ among themselves by nH_2, nM, or nO, we may have not only $n(MO)$, $n(M_3O_4)$, $n(M_2O_3)$, and $n(MO_2)$, which, if $n=24$, will be—

$$M_{24}O_{24}\ldots M_{24}O_{32}\ldots M_{24}O_{36}\ldots M_{24}O_{48},$$

but bodies intermediate between these, the general formula being $M_{24}O_{24}+nO$. The coefficient of M for oxides like periclase, magnetite, hematite, polianite, quartz, and cassiterite will, however, not be 24, but approximately 2400.

§ 12. The existence of oxides of such intermediate composition has lately been insisted upon by Schützenberger, who shows that oxides of tin, mercury, copper, lead, zinc, manganese, and iron, when prepared in different ways, vary considerably in their proportions of oxygen. Thus cupric oxide from the calcined nitrate evolves oxygen when dissolved in nitric acid, and ferric oxide got by a similar process, if we assume the formula to be Fe_2O_3, gives the value of Fe=54; while for a similar oxide from the calcined oxalate, if we admit the same formula, we get Fe=56. In other words, 24 parts of oxygen are in the first case united with 54, and in the second with 56, parts of iron.

Boutlerow, who confirms the results of Schützenberger, concludes from similar studies that the combining weight of carbon may vary from 12·0 to 11·8, and supposes a change in the chemical value of that element; that is to say, the amount of carbon united with 32 parts of oxygen may vary from 12·0 to 11·8 parts, the resulting compounds, though not identical, being similar in chemical properties. Schützenberger, in like manner, admits the variability in value on either side of a point of maximum stability, which is in most cases attained. He concludes that "all of these results lead directly to the conclusion that the law of definite proportions is not rigorously exact, unless we are willing to admit in each particular case the existence of compounds more or less oxygenised than those hitherto known to us, which may occur mixed with the products of the reaction."* This suggested explanation of the facts, which, however, does not appear to be acceptable to Schützenberger, Boutlerow, or Cooke (who has published a valuable discussion on the subject), is nevertheless an approximation to what we conceive to be the true one, believing, however, that the oxides with more or less than the ordinary proportions of oxygen are not necessarily nor even probably (with some apparent exceptions) admixtures, but definite intermediate oxides, being members of great progressive series.

§ 13. The conception that these variations in composition are due to the presence of admixed portions of more and less oxygenised compounds is not acceptable to Schützenberger, for the evident reason that it becomes inadmissible when we have to deal with gaseous or vaporous species, such as carbon dioxide and as water-vapour. This, as generated by passing hydrogen gas over ignited copper oxide, presents, according to him, variations in the proportions of H : O, of from 1·00 : 7·95 to 1·00 : 8·15 by weight; that corresponding rigorously to the volumetric relation 2 : 1, being, from the most probable data, very nearly 1·00 : 7·98. Water thus obtained, with an excess of oxygen, though neutral, possesses, according to Schützenberger, oxidising powers; the same being true of carbon dioxide with the larger proportion of oxygen.

§ 14. Prof. Cooke, as we have seen (§ 10) had already in 1860 arrived at a conclusion similar to that subsequently reached by Schützenberger and by Boutlerow,—namely, that "the law of definite proportions is not so absolute as has been hitherto supposed," but that the chemical value of the elements may change within certain limits. In his discussion, in 1883, of these views as enunciated by the chemists just named, Cooke remarks:—"Such opinions are certainly very revolutionary, and if they prevail must entirely change the fundamental conception

* Read before the National Academy of Sciences at Washington April 19, 1887.

† *Comptes Rendus de l'Académie des Sciences*, xli., 1167; sur les rapports entre quelques composés different par H_2 et O_2.—"Nous portent à admettre un rapport intime entre les corps différants par H_2."

‡ Cooke, *American Journal of Science*, 1883, xxvi., 310-316, resuming the conclusions of his studies of 1885 and 1860.

§ Hunt, "Chemical and Geological Essays," 447.

* See, for the papers of Schützenberger and Boutlerow, *Bull. de la Soc. Chimique de Paris* 1883, xxxix., 257-263; also an extended analysis of them in the *American Journal of Science*, 1883, xxvi., 63. The results obtained, according to Schützenberger, "conduisent directement a cette conclusion, que la loi des proportions definies n'est pas rigoreuse, a moins qu'on ne veuille admettre dans chaque cas particulier l'existence des composés plus oxigénés on moins oxigénés que ceux connus jusqu'a présent, et qui se trouveraient en mélange avec le produit principal de la réaction."

of chemical philosophy. Chemical combination can no longer be regarded as the juxtaposition of the definite invariable masses which we call atoms, but must be considered as the 'reciprocal saturation' or 'interpenetration' of masses which may vary with the relative strength of their chemical energy acting at the time; and this change of the fundamental conception is inconsistent with the atomic theory, and with the superstructure which modern chemistry has built upon it." Cooke adds that, while holding that "the atomic theory is the only basis on which a consistent philosophy can at present be built," "he is rather drawn to that view of nature which refers all differences between substances to dynamical causes, and which regards the atomic theory as only a temporary expedient for representing the facts of chemistry to the mind."*

§ 15. It has already been shown that the writer does not share the interpretation of these variations in composition given by Cooke, Schützenberger, and Boutlerow, but regards, as was already said in 1867, the facts "from which some have suggested a deviation from the law of definite proportions" as "only an expression of that law in a higher form," believing that, so far as we yet know, the laws of measure, number, and weight in chemistry are invariable. To one who since 1853 has persistently combatted the atomic hypothesis as contrary to a sound philosophy,† and throughout all the succeeding years has sought to build up without it a new theory of chemistry upon a dynamic basis, it is, however, no small satisfaction to find that Prof. Cooke, who has been among the ablest defenders of this famous hypothesis, is at last led to look upon it as "only a temporary expedient for representing the facts of chemistry to the mind."

§ 16. The question here arises whether in gaseous species like water-vapour, H_2O, and carbon dioxide, CO_2, whose integral or equivalent weights are represented by these formulas, it is possible to admit such variations in composition as have been already signalised, and as we have sought to explain in the case of liquid and solid species of high equivalent weights. We recall what has been said (§ 2, § 4) as to the process of homogeneous dissociation when the hexad integer of sulphur vapour at 500° is changed at higher temperatures into three dyad integers, and the dyad integer of iodine is at 1500° disintegrated into two monad integers, as also the integrations of pentine and aldehyd, and the homogeneous disintegration of their so-called polymers; and again, the fact that the dyad integer of hydrogen (H_2), after combining integrally with a similar integer of chlorine (Cl_2), is dissociated into two dyad integers of chlorhydric gas, 2(HCl), the double process of heterogeneous integration and homogeneous disintegration taking place without a perceptible interval, so that no change of volume is observed. The union of hydrogen and oxygen, in like manner, may be supposed to give rise temporarily to a more condensed vaporous species, which subsequently undergoes homogeneous disintegration or dissociation like sulphur and iodine vapours, or like H_2Cl_2, or dipentine,—

$$C_{10}H_{16}=2(C_5H_8).$$

Thus, while ordinary water-vapour, with the ratio for hydrogen and oxygen of 2 : 1 by volume, and of 1·0 : 7·9816 by weight, equals $(H_{100}O_{50})\div 50$, the ratio 1·0 : 8·142 corresponds to $(H_{100}O_{51})\div 50$. These figures, arbitrarily assumed, will serve for illustration; but it may be remarked that the integral weight for the gaseous species, $H_{100}O_{51}=898{\cdot}16$, which may be supposed to have a momentary existence before homogeneous disintegration, is not very much greater than the weights observed for the vapours of stannic and aluminic iodides, $SnI_4=534{\cdot}1$, and $Al_2I_6=813{\cdot}2$.

§ 17. The integral weight of liquid water with the usual volumetric ratios is represented by—

$$1628(H_2O)=29{,}244,$$

as has been shown at length in "A New Basis for Chemistry." The great importance of this datum is due to the fact that the weight of this liquid at its maximum density has, for obvious reasons, been assumed as the unit of specific gravity for all liquids and solids. For similar reasons of convenience a second arbitrary unit, the weight of atmospheric air at 0° and 760 m.m. pressure, has been adopted as the unit of specific gravity for all gases and vapours. Hydrogen gas at the same temperature and pressure, which gives us the unit of integral weight, would, however, seem to be the natural unit of specific gravity for all bodies whatsoever, and in fact the accepted integral or equivalent weights for gases and vapours are but the specific gravities of these bodies referred to hydrogen, $H_2=2{\cdot}0$; which is not only the unit of weight and volume adopted by chemists for all gases and vapours, but also the unit of weight in all calculations of the equivalent or integral weights of liquid and solid species. The values thus assigned not only to water-vapour and to gaseous carbon dioxide, but to ice, to water, to liquid and solid carbon dioxide, to quartz, and to calcite, are really the specific gravities—hydrogen gas, $H_2=2$ 0, being unity—of the normal gaseous species H_2O and CO_2, and of the possible gaseous species, silicon dioxide, SiO_2, and calcium carbonate, $CCaO_3$, which by integration, or so-called polymerisation, give rise to the liquid and solid forms of water and carbon dioxide, to tridymite and quartz, to calcite and aragonite.

If now we compare the densities of these various liquid and solid species with those of the known gaseous species H_2O and CO_2, or, in the last analysis, with the density of the hydrogen unit, H_2, we obtain a direct expression for the condensation suffered by these in passing into the liquid and solid integers. In other words, we get the specific gravity of these bodies, the dyad integer of hydrogen at 0° and 760 m.m. ($H_2=2{\cdot}0$) being unity. That of water-vapour at 100° and 760 m.m., represented by $H_2O=17{\cdot}9633$; the same volume of water at 100 being represented by $1628(H_2O)=29{,}244$. The density of all species, whether gaseous, liquid, or solid, is thus compared with that of their volumetric equivalent of hydrogen gas, ($H_2=2{\cdot}0$), at the standard temperature and pressure, and is seen to be for liquids and solids, not less than for gases and vapours, a function of their equivalent or integral weights.

§ 18. The hardness and chemical indifference of solid species are in like manner, as we have elsewhere endeavoured to show, functions of their integral weights For the study of these relations we have calculated for the species to be compared the values got by the proportion $d : p :: 1 : v$, in which d = density of weight of the liquid or solid species compared with water, $1628\,(H_2O)$ at 4°; and p = the weight of the gaseous species (or so-called molecular weight) compared with H_2 at 0° and 760 m.m. The relation $d : p$ is thus that between the densities of the solid (or liquid) and the gaseous species, and the so-called molecular volume = v is the reciprocal of the coefficient of the condensation suffered by the gaseous in passing into the solid species. The hardness and the chemical indifference of related species are inversely as the values of v.

For such species, with more or less complex formulas, it becomes necessary to fix comparable terms for p, and in the case of compound oxidised species, of which the vapour-density is unknown, we have assumed, as the unit for p, a weight including that of H = 1·0, of Cl = 35·5, or of $O\div 2=8{\cdot}0$. By thus adopting a combining weight of 8·0 for oxygen, as a basis, we get a unit which gives a common term of comparison for oxides, sulphides, chlorides, fluorides, and for intermediate compounds like the oxysulphides and oxyfluorides common in native species. It is of course a hypothetical unit, which for elemental species and for fluorides, chlorides, &c., correspond,

* *American Journal of Science* (1883), xxvi., 310. 316.

† "A New Basis for Chemistry," pp. 60-67. See also in this connection G. A. Hirn, "La Cinétique Moderne et le Dynamisme de l'avenir," *Comptes Rendus de l'Acad. des Sciences*, Sept. 20, 1886.

with the normal vaporous species; but for oxidised species is some fraction thereof, as in the cases of water, of spinels, and other oxides.

We may readily extend this system of hypothetical units to silicates, carbonates, sulphates, phosphates, and more complex species, by dividing in all cases the empirical equivalent weight by twice the number of oxygen portions (O = 16·0, or more exactly 15·9633) plus the number of chlorine or fluorine portions.* We have thus for example,—

		p
Forsterite	$SiMg_2O_4 = 140 \div 8$..	17·50
Calcium carbonate	$CCaO_3 = 100 \div 6$	16·66
Calcium sulphate..	$SCaO_4 = 136 \div 8$	17·00
Gypsum..	$SCaO_4 \cdot 2(H_2O) = 172 \div 12$ ..	14·33
Apatite	$3(P_2Ca_3O_8) \cdot CaF_2 = 908 \div 50$..	18·16

§ 19. Such fractional units are convenient for the purpose of comparing the varying condensation in species belonging to the respective groups, but it will be borne in mind that in order to construct formulas which shall represent the true equivalent weights of liquid and solid species, we must multiply instead of dividing the formulas hitherto accepted as representing the normal species. The combining weight of these must be the unit for fixing the equivalent weights and the true formulas of such liquid and solid species, which are generated by integration or polymerisation from the normal species. This, though known to us in the volatile elements, and in compounds like carbon dioxide, water-vapour, formic and acetic aldehyds, and pentine, is unknown in the case of bodies like carbon, silicon, silicon dioxide, and most of the solid oxides; as also in the various silicates, carbonates, sulphates, and phosphates. For all these we choose, as representing the normal species, the simplest formula which satisfies the relations of valency, and which corresponds to the theoretical gaseous or volatile species.

The writer has sought in the preceding pages to illustrate and set forth in detail several points which were more briefly noticed in his lately published volume entitled "A New Basis for Chemistry," to which this paper may be considered as a supplement.

NOTES ON SOME PECULIAR VOLTAIC COMBINATIONS.†

By C. R. ALDER WRIGHT, D.Sc., F.R.S., and C. THOMPSON, F.C.S.

I. *Gas-film Electro-motors.*

The combinations referred to under this title constitute a class of cells in which the essential feature is that one or both of the "plates" of the combination consists of a film or aura of gas attracted physically to, or condensed upon, the surface of an electrically conducting solid not appreciably acted upon chemically during the production of a current, but simply serving as a support for the gas-film, which does undergo chemical change. Grove's well-known oxygen hydrogen "gas-battery," and the various analogous combinations examined subsequently by others, are cells of this kind, where *both* plates are gas-films. We have recently examined a number of combinations intermediate in character between these ordinary one-fluid or two-fluid cells, *one* plate only being a gas-film.

Single gas-film electro-motors, as these may be conveniently termed, may be ranged in two classes, according as the solid plate supporting the gas film acquires the higher or lower potential. When air, oxygen, or other electro-negative gas constitutes the film, the opposed plate being an oxidisable metal (*e.g.* copper or zinc), the former is the case; instead of an oxidisable metal, we find that an incorrodible plate (*e.g.* platinum) immersed in an oxidisable fluid (*e.g.* an acid solution of ferrous sulphate, or an alkaline one of pyrogallol) may often be employed. Gas-films of hydrogen, coal-gas and similar oxidisable gases opposed to incorrodible plates immersed in oxidising fluids (*e.g.* platinum in nitric acid or alkaline permanganate solution) furnish cells of the second class. In all cases the E.M.F. of the combination falls rapidly with increasing current density, owing to the using up of the gas-film more rapidly than the physical attracting power of the supporting plate can renew it, even under the most favourable conditions, *i.e.*, when supported horizontally on the surface of the electrolytic fluid employed so as to be simultaneously in contact therewith, and with an atmosphere of the gas experimented with.

In most cases it is desirable that the gas-film plate should not be in direct contact with the alterable fluid surrounding the plate opposed thereto; the cell thus takes the form of a two-fluid arrangement, the two liquids being on opposite sides of a porous partition, or contained in separate vessels united by an inverted syphon or asbestos wick, &c For example, a plate or tray of spongy platinum opposed to a piece of platinum foil, the former being arranged on the surface of a solution of caustic soda in contact with the air, and the latter immersed in a solution of pyrogallol in caustic soda, conveniently protected from direct contact with air by being closed in an inverted test-tube, dipping into a somewhat more dense soda solution, connected by a syphon, &c., with the other solution.

We find that with cells of the first class, especially those where air is the gas employed, much more concordant valuations of the E.M.F. set up when generating only minute currents may be obtained, than might *à priori* be expected, provided certain precautions are taken; and that fairly accurate valuations are possible of the effect produced by varying the nature of the "aëration plate" (plate supporting the air-film), the strength and nature of the fluid surrounding it, and so on. Thus, the simplest cells of this kind (such as a plate of amalgamated zinc immersed in caustic soda solution, on the surface of which the aëration plate is arranged) appear in general to produce a higher E.M.F. the stronger the solution. The effect of varying the aëration plate, all else remaining the same, is independent of the nature of the oxidisable metal, but is influenced to some extent by the strength of the electrolytic fluid, and varies with its nature. For instance, the effect of substituting a tray of spongy platinum for an aëration plate of smooth platinum foil is to cause an increment in the E.M.F. of the cell, the numerical value of which is sensibly the same, whether zinc or lead be the oxidisable metal opposed, provided the soda solution be the same; but it is not the same, whether the soda solution be strong or weak, and is widely different, if, instead of caustic soda, dilute sulphuric acid be used as the electrolytic fluid, and similarly in other cases.

Somewhat unexpected results were obtained when certain of the more difficultly oxidisable metals (mercury, silver, and gold), were opposed to aëration plates in contact with appropriate electrolytic fluids: oxidation and solution took place with celerity. Thus mercury and silver readily form mercurous and argentic sulphates if immersed in dilute sulphuric acid, on which a platinum sponge aëration plate is arranged, on completing this circuit through a moderately large external resistance: the current produced is readily measurable by inclosing in the circuit a small silver voltameter. Silver similarly dissolves in ammonia solution (preferably containing some ammonium chloride or sulphate (when opposed to an aëration plate, as also does gold in potassium cyanide solution. Hitherto we have not succeeded in dissolving platinum in any combination of the kind.

* In the writer's essay on a Natural System in Mineralogy ("Mineral Physiology and Physiography," 279-401) the values of p and v have been thus determined. These silicates are there represented by a new notation, which employs symbols in small letters to represent quantivalent ratios; the combining weights of the elements being divided by their valency, and in all cases followed by their coefficients The formula of forsterite thus becomes $(mg_1\ i^1)o_2$, that of orthoclase $(k_1al_3si_{12})o_{16}$, and that of topaz $(al_3si_2)o_4fl$.

† Read before the Chemical Section of the British Association, Manchester Meeting.

II. *Voltaic Circles producible by the Mutual Neutralisation of Acid and Alkaline Fluids, supplemented by other Agencies.*

It has long been known that if an acid and an alkaline solution be united (by means of a wick or syphon, &c.), a considerable current is producible for a short time in the external circuit, connecting two plates of platinum, &c., immersed in the two fluids respectively; but this current very rapidly diminishes to infinitesimal proportions. The usual explanation of this, given in the text-books, is that during the passage of the current electrolysis takes place, causing the development of free hydrogen on the surface of the plate in the acid fluid, and of oxygen on that of the other plate, so that an inverse E.M.F. is set up by the incipient gas battery thus produced, which by-and-bye becomes practically equal to the E.M.F. due to the chemical action of neutralisation. No direct quantitative proof of this electrolysis, however, appears ever to have been given as regards the hydrogen; whilst as regards the oxygen, the main evidence is the observation of Becquerel, that if nitric acid be the acid and caustic potash the alkali, a tolerably constant current is developed, the flow of which is accompanied by continuous evolution of oxygen from the alkali plate, whence the term "pile à oxygène" applied by him to the combination, the nitric acid being simultaneously reduced to lower oxides of nitrogen.

Whilst studying the action of various gas film cells, we had occasion to make some experiments with "neutralisation cells," *i.e.*, cells in which one essential feature is that an acid and an alkaline fluid are used, which neutralise one another during the action; thus in the case of Becquerel's "pile à oxygène," the scheme—

$$2HNO_3 \mid 2KNO_3 \mid 2KOH$$
$$H_2 \mid 2NO_3K \mid 2NO_3K \mid OH_2 \mid O$$

represents the primary action, the hydrogen, of course, not appearing as such, but reducing the nitric acid. We found it difficult to obtain by titration very sharp figures, proving that one equivalent of acid disappears on one side and one of alkali on the other, for every equivalent of silver thrown down by the current in a silver voltameter; but our results always at least approximated to this. On the other hand we found no difficulty at all in proving that in Becquerel's "pile à oxygène," 8 m.grms. of oxygen (5·6 c.c. at 0° and 760 m.m.) are evolved for every 108 m.grms. of silver deposited. Moreover, we found that various oxidising fluids can be substituted for nitric acid without affecting this result; thus, solution of potassium permanganate or ferricyanides acidulated with sulphuric acid; chromic acid dissolved in sulphuric acid; hydrochloric acid saturated with chlorine; or dilute sulphuric acid saturated with bromine, all cause oxygen evolutions (though not all as rapidly as nitric acid) in precisely the quantity equivalent to the silver deposited.

It occurred to us that by suitably modifying the liquids used we might obtain similar quantitative evidence as regards the hydrogen. If nitric acid or other oxidising agent can be reduced by the nascent hydrogen whilst the oxygen escapes, it might be expected that if some highly oxidisable substance is dissolved in the caustic alkali used, the oxygen might be arrested whilst still nascent, whilst conversely the hydrogen escaped free at the other side; and this, in fact, we ultimately succeeded in doing. Several oxidisable substances, however, proved too weak; thus, sulphites and ferrocyanides caused no distinct hydrogen evolutions; but caustic soda containing hyposulphite (Schützenberger's "hydrosulphite") or pyrogallol caused continuous evolution of hydrogen in quantity strictly proportionate to the current passing, *i.e.*, 11·2 c.c. normal for every 108 m.grms. of silver deposited.

Precisely the same result was obtained when certain metals not ordinarily soluble in cold acid or alkaline fluids, and simple caustic soda solution were used instead of these alkaline oxidisable fluids with platinum plates. Thus, tin and lead immersed in caustic soda and opposed to platinum in dilute sulphuric acid dissolved freely, producing copious evolutions of hydrogen from the platinum plate surface. The same result was obtained on substituting copper and ammonia solution for tin and caustic soda; whilst by employing strongly alkaline potassium cyanide solutions, mercury, silver, gold, and palladium were readily dissolved with hydrogen evolutions from the opposed platinum plate immersed in dilute sulphuric acid. In all these different cases the amount of hydrogen obtained was exactly proportionate to the current flowing, 11·2 c.c. being collected for every m.grm. equivalent of silver deposited in the voltameter.

A NEW METHOD FOR DETERMINING MICRO-ORGANISMS IN AIR.*

By Professor CARNELLEY and THOS. WILSON,
University College, Dundee.

THIS is a modification of Hesse's well-known process. It consists essentially in the substitution of a flat-bottomed conical flask for a Hesse's tube. Its chief advantages are:—(1) Much smaller cost of flask and fittings as compared with Hesse's tubes; (2) very much fewer breakages during sterilisation; (3) great economy in jelly; (4) freedom from leakage during sterilisation; (5) results not vitiated by aërial currents.

THE SOLUBILITY OF ISOMERIC ORGANIC COMPOUNDS.*

By Professor CARNELLEY, D.Sc., and Dr. A. THOMSON,
University College, Dundee.

1. *For any series of isomeric organic compounds the order of solubility is the same as the order of fusibility, i.e.* the most fusible compound is also the most soluble. (*Cf.* Carnelley, *Phil. Mag.* (5); also Tilden, *Phil. Trans.*).

This is shown to hold true in a very large number of cases, whilst there are very few exceptions, and those of a doubtful character.

2. *The order of solubility of two or more isomeric compounds is independent of the nature of the solvent.* This has been experimentally proved, more particularly in the case of meta- and para-nitraniline, the solubility of each of which in thirteen different solvents has been determined. Also by a considerable number of cases taken from literature.

3. *The ratio of the solubilities of two isomers in a given solvent is constant, and is therefore independent of the nature of the solvent.* So that—

$$\frac{\text{Solubility of A in any solvent}}{\text{Solubility of B in the same solvent}} = \text{constant.}$$

This has been proved for meta- and para-nitraniline in respect of thirteen different and very varied solvents.

ON THE COMPONENTS OF THE RARE EARTHS GIVING ABSORPTION-SPECTRA.

By GERHARD KRÜSS and L. F. NILSON.

(Continued from p. 137).

LASTLY, the accompanying measurements (see Table XII.) of some mother-liquors are of importance for the study of the components of erbium and of thulium. They

* Read before the Chemical Section of the British Association Manchester Meeting.

XI. *b. Euxenite from Arendal.*

Position of maximum darkness. Position of Telescope-drum.	Position of maximum darkness. Wave-length.	Wave-lengths formerly observed.	For.	Intensity of the Absorption-bands of the Several Fractions. I.	II.	III.	IV.	V.	VI.
2353	729·0	728·3	Di	Strong.	Rather strong.	Rather strong,	Rather strong.	Rather strong.	Medium stro
2394	716·4	—	?	—	—	—	—	—	—
2415	683·2	684·0	Tm	Extremely faint.	Very faint.	Faint.	Faint.	Faint.	Rather faint
2419	680·0	679·4	Di	Very faint.	Extremely faint.	—	—	—	—
2455	654·7	654·7	Er	Rather strong.	Strong.	Strong.	Strong.	Strong.	Strong.
2480	640·6	640·4	X	—	—	—	—	—	—
2505	621·1	621·1	Di	Faint.	Extremely faint.	—	—	—	—
2568	591·5	591·5	Di	Rather faint.	Very faint.	Extremely faint.	—	—	—
2595	579·6	579·2	Di	Very strong.	Strong.	Rather strong.	Faint.	Faint.	Faint.
2604	575·8	575·4	Di	Strong.	Rather strong.	Faint.	Very faint.	Very faint.	Extremely fai
2682	542·6	542·6	X	Rather strong.	Rather strong.	Strong.	Strong.	Strong.	Strong.
2698	535·5	536·3	X	Rather strong.	Rather strong.	Strong.	Strong.	Strong.	Strong.
2740	523·6	523·1	Er	Strong.	Strong.	Strong.	Very strong.	Very strong.	Extremely strong.
2747	521·6	521·5	Di	Rather strong.	Rather strong.	Rather strong.	Rather faint.	Very faint.	—
2780	512·5	512·2	Di	Rather faint.	Faint.	—	—	—	—
2872	485·9	485·5	X	—	—	Rather faint.	Rather strong.	Rather strong.	Rather strong
2887	482·5	482·0	Di	Rather strong.	Strong.	Rather faint.	—	—	—
2900	474·9	474·5	X	Rather strong.	Rather strong.	Rather strong.	Rather strong.	Rather strong.	Rather faint
2943	469·4	469·0	Di	—	—	Very faint.	Very faint.	Very faint.	Faint.
2974	462·3	463·2	Sm	Rather faint.	Very faint.	—	—	—	—
3028	452·6	453—449	X	Very strong.	Strongest line of this fraction.	Very strong.	Extremely strong.	Extremely strong.	Extremely strong.
3076	444·2	444·7	Di	Rather strong.	Rather faint.	Faint.	Faint.	Faint.	Faint.
3163	428·9	428·5	X	Rather strong.	Rather strong.	Rather strong,	Rather faint.	Faint.	Faint.
3240	417·3	416·7	Sm	Strong.	Strong.	Strong.	Strong.	Strong.	Strong.

XII. *c. Mother Liquors obtained in Preparing Pure Ytterbia.*

Position of maximum darkness. Position of Telescope-drum.	Position of maximum darkness. Wave-length.	Wave-length formerly observed.	For.	Intensity of Absorption-bands in Spectra of the Several Series. 41—46.	47—53.	54—60.	61—62.	63—65.	66—67.
2394	716·4	—	?	Very faint.	Extremely faint.	—	—	—	—
2413	684·4	684·0	Tm	Strong.	Strong.	Rather faint.	Very faint.	Extremely faint.	Scarce visibl
2455	654·7	654·7	Er	Extremely faint.	Extremely faint.	Scarce visible.	—	—	—
2682	542·6	542·6	X	Scarce visible.	—	—	—	—	—
2740	523·6	523·1	Er	Very faint.	Scarce visible.	—	—	—	—
2872	485·9	485·5	X	Extremely faint.	—	—	—	—	—
2920	474·9	474·5	X	Scarce visible.	—	—	—	—	—
2693	464·9	465·0	Tm	Rather strong.	Faint, but clear.	Extremely faint.	Scarce visible.	—	—

are syrupy nitrates obtained in the preparation of pure ytterbium compounds by decomposing the nitrates partly from the above-named euxenites of Hitterö and partly from other materials of different origins.

(To be continued).

ON A PARTIAL SEPARATION OF THE CONSTITUENTS OF A SOLUTION DURING EXPANSION BY RISE OF TEMPERATURE.*

By Prof. J. W. MALLET, F.R.S.

It was observed in regard to a thermometer containing coloured alcohol, the colour due probably to cochineal, that on several occasions when rise of temperature occurred somewhat gradually in the room after rather severely cold weather, the upper part of the column of liquid was colourless or nearly so, while no deposition of any solid colouring-matter could be seen in the bulb or the lower part of the tube. Colourless alcohol had apparently separated itself by expansion from a still perfect solution left behind.

This led to making some experiments with solutions, partly aqueous, partly alcoholic, of several colloid substances, such as starch, tannin, caramel, albumen, and gelatin. Each solution was placed in a flask of about half a litre capacity, which was brought to near 0° C by being surrounded with ice, filled to the mouth with the solution at this temperature, and closed by a cork traversed by a glass tube of small but not capillary bore (about 4 m.m. interior diameter) 15 or 20 c.m. long, and having a glass stopcock in the middle of its length. The ice having been removed, the temperature of the flask and its contents was allowed to rise gradually in a warm room until the head of the column of liquid in the tube, originally one or two centimetres below the stopcock, had reached to about as far above it. The stopcock was then cautiously closed, and the small portion of liquid above it, removed by means of a capillary pipette, was submitted to appropriate tests for the substance in solution in the contents of the body of the flask. In contrast with a sample of equal volume taken from the flask itself, the

* Read before the Chemical Section of the British Association, Manchester Meeting.

b. Euxenite from Arendal (continued).

Intensity of the Absorption-bands of the Several Fractions.

VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
Medium strong.	Rather faint.	Rather faint.	Faint.	Very faint.	Extremely faint.	—	—
—	Extremely faint.	Very faint.	Very faint.	Very faint.	Extremely faint.	Extremely faint.	—
Rather strong.	Rather strong.	Strong.	Strong as Er line $\lambda=6547$.	Stronger than 654 7.	Strong.	Strong.	Strong.
—	—	—	—	—	—	—	—
Strong.	Strong.	Strong.	Rather strong.	Rather strong.	Rather strong.	Rather faint.	Faint.
Extremely faint.	Very faint.	Very faint.	Very faint.	Very faint.	Extremely faint.	Extremely faint.	Extremely faint.
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
Very faint.	—	—	—	—	—	—	—
Scarce visible.	—	—	—	—	—	—	—
Stronger than 536·3.	Strong.	Strong.	Strong.	Rather strong.	Rather faint	Faint.	Very faint.
Rather strong.	Rather faint.	Faint.	Faint.	Very faint.	Extremely faint.	—	—
Very strong.	Strong.	Strong.	Strong.	Strong.	Strong.	Strong.	Strong.
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
Strong.	Strong as X $\lambda=452\cdot6$.	Very strong.	Fainter than 452·6.	Rather strong.	Rather strong.	Rather strong.	Rather strong.
—	—	—	—	—	—	—	—
Rather faint.	Faint.	Very faint.	Extremely faint.	—	—	—	—
Faint.	Faint.	Very faint.	—	—	—	—	—
—	—	—	—	—	—	—	—
Extremely strong.	Extremely strong.	Very strong.	Strongest line.	Strong.	Very strong.	Rather strong.	Very faint.
Faint.	Faint.	Faint.	Faint.	Faint.	Very faint.	Extremely faint.	—
Very faint.	Extremely faint.	—	—	—	—	—	—
Strong.	Rather strong.	Faint.	Extremely faint.	—	—	—	—

portion which had been slowly driven up by expansion was found to contain a diminished amount of material in solution, often a very notably diminished amount, and in two or three instances practically none.

All the solutions tried were filtered beforehand through four thicknesses of fine close filtering paper, so as to remove suspended particles of solid matter. No film consisting of, or rich in, the material dissolved in the bulk of the liquid could be detected on the inner surface of the tube in its upper part, so that the separation could not well be attributed to surface adhesion.

The extent of exposure to the air on the small cross-section of the tube would hardly allow of an explanation being found in chemical change of the dissolved material.

The term apantlesis (ἀπάντλησις) might be used to signify a draining away of some of the molecules of the solvent undergoing expansion from amongst those of the colloid solid in solution. Such draining away would seem to connect itself on to change in the opposite direction, but leading to the same result, when the colloid begins to separate out by gelatinising on cooling.

The conditions which seemed most to influence the production and the distinctness of the phenomenon were—first, the proportion of the colloid solid in solution; and second, the time occupied in the rise of temperature of the liquid. In regard to each of these conditions, there appeared to be a certain point at which the separation was most notable, above or below which it became gradually less distinct, and sufficiently removed from which it was not observable at all.

ON ORGANIC VANADATES.*

By JOHN A. HALL, Owens College.

I HAVE obtained a series of organic ortho-vanadates by the action of an alkyl bromide on silver ortho-vanadate. These bodies are yellow liquids, which decompose on distillation under the ordinary pressure, but the lower members can be distilled under reduced pressure.

Methyl vanadate could not be obtained.

Ethyl vanadate boils at 150° C. under a pressure of 120 mm. The vapour density is normal. The specific gravity is 1·167 at 17·5° C.

The refractive indices are—

For	1·473
„ Sodium	1·481
„ Thallium	1·483

Amyl pyro-vanadate is the only pyro-vanadate which I have been able to obtain in sufficient quantity for analysis.

No meta-vanadates could be obtained, an ether and vanadium pentoxide always being formed.

All these organic vanadates are immediately decomposed by water, with the formation of vanadic acid, thus resembling the organic arsenates more closely than the phosphates.

As I was unable to prepare methyl vanadate, I tried the action of methyl iodide on silver phosphate, and obtained methyl phosphate, a colourless liquid, boiling at 190° C. (uncorrected).

* Read before the Chemical Section of the British Association, Manchester Meeting.

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT.

Fellow of the American Association for the Advancement of Science; Member of the Academy of Natural Sciences, Philadelphia; of the Berliner Chemische Gesellschaft, &c., &c.

(Continued from p. 135).

Carbhydrate Filtrate.

A PORTION, representing a certain volume of the *aqueous extract*, of the *carbhydrate filtrate* was evaporated, dried,

* Reprinted from the *Transactions of the American Philosophical Society.*

and weighed. It yielded 7·65 per cent of the total solids of the *aqueous extract residue*. A known weight of the *carbhydrate filtrate residue* was dissolved in water and heated over a water-bath with Fehling's solution, and the amount of glucose present estimated gravimetrically from the weight of the cupric oxide. It was estimated as 4·47 per cent. Another portion of the *carbhydrate filtrate residue* was boiled with 83 per cent alcohol. A precipitate formed on cooling, which was collected on a weighed filter, dried, and weighed. It yielded 1·98 per cent. The 83 per cent alcohol precipitate was identified as saponin by the usual tests. The *carbhydrate filtrate residue* was precipitated by acetate of lead and the precipitate examined qualitatively for organic acids. The lead precipitate was decomposed by sulphuretted hydrogen and filtered, and the filtrate concentrated over a water-bath, and mixed with lime-water until turbid. The turbidity did not clear on adding dilute acetic acid.

The *aqueous extract* was examined for tannin, and with negative results. Calcium oxalate was present.

Extract (3), *the Green Part of the Leaf.*

The residual powder was dried from all traces of alcohol, and cold distilled water was allowed to slowly percolate through the powder. The *extract* was coloured, and slightly acid in reaction. A definite volume of the *extract* was evaporated, dried, and weighed, and the ash calculated from incinerating a known weight of the *residue*.

Total Solids.

	Per cent.
Aqueous residue dried between 100° C. and 110° ..	4·35
,, ,, ash	0·40

Gum.

One volume of the *aqueous extract* was mixed with two volumes of stronger alcohol. The precipitate was collected after twenty-four hours, washed with 66 per cent alcohol, dried, and weighed. The precipitate and filter were incinerated, and the ash estimated.

	Per cent.
Weight of precipitate by stronger alcohol yielded	0·775
,, ,, ash yielded	0·125

Carbhydrates.

The gum filtrate and wash alcohol were concentrated at a low temperature, and the residual liquid mixed with four volumes of stronger alcohol. The resulting precipitate was rapidly filtered and collected. The percentage of *carbhydrates* was estimated gravimetrically from a copper solution in the usual way. It amounted to 0·525 per cent.

Carbhydrate Filtrate.

The *filtrate* was evaporated to dryness. A part of the *residue* was boiled with 83 per cent alcohol. On cooling, a precipitate formed. It was identified by the usual tests as saponin. Another portion of the *residue* was precipitated with the basic acetate of lead. The lead precipitate was decomposed by sulphuretted hydrogen, the solution filtered, and the filtrate evaporated over a water-bath until all odour of sulphuretted hydrogen was dissipated. A part of the lead sulphide filtrate was mixed with lime-water, and a precipitate formed not completely dissolved by acetic acid. The remainder of the lead sulphide filtrate was allowed to evaporate over sulphuric acid. The residue consisted of a mass of fine crystals radiating from a centre.*

The crystals gave a very acid reaction when placed on moistened blue litmus-paper. They turned black and left a residue when heated on platinum foil, and the residue was slowly dissolved by nitric or hydrochloric acid. The quantity of residue was very small, and no effervescence was observed. The melting-point of the crystals was taken. A small quantity was placed in a tube with thin walls, and gradually heated; at 150° C. the substance sublimed, leaving a white cloudy stain on the inner surface of the tube; at 190° C. this cloudy stain changed to a pale green spot, and with increasing temperature to 210° C. no further change was noted. Dry sodium carbonate was added to an aqueous solution of the crystals, and a slight effervescence was observed. Some iron was separated which possibly was in combination with the crystalline principle. Negative results followed tests for formates, acetates, malates, tartrates, citrates, phosphates, oxalates, alkaloids, and glucosides.

The amount of glucose present in the *aqueous extract* was too small to determine quantitatively. Negative results for tannin.

Extract (4), *the Yellow Base of the Leaf.*

The residual powder from the alcoholic maceration was dried and replaced in the percolator. Cold distilled water was allowed to percolate slowly through the powder. The *aqueous extract* was slightly acid in reaction. A known measure of it was evaporated, dried, and weighed. The ash was determined from a part of the *aqueous extract residue*.

Total Solids.

	Per cent.
Aqueous residue dried between 100° and 110° C. ..	11·35
,, ,, ash	3·10

Gum.

One volume of the *aqueous extract* was mixed with two volumes of stronger alcohol. The precipitate was collected, washed with 66 per cent alcohol, dried, and weighed. The ash was calculated from incinerating the precipitate, and deducting the filter.

	Per cent.
Weight by precipitate by stronger alcohol yielded	3·850
,, ,, ash yielded	0·676

Carbhydrates.

The filtrate and wash alcohol from the gum precipitate were concentrated at a low temperature. The residual liquid was mixed with four volumes of stronger alcohol, when a precipitate formed, and was rapidly filtered off. The *carbhydrates* were dissolved in water, boiled with dilute acid, and the liquid rendered alkaline and heated over a water-bath with Fehling's solution. The amount of carbhydrates was estimated gravimetrically in the usual way. It gave 2·95 per cent.

Carbhydrate Filtrate.

The *filtrate residue* was examined for glucose, and traces of it were present. The *filtrate residue* was precipitated with acetate of lead, and the lead precipitate was dissolved in water and decomposed by sulphuretted hydrogen. The lead sulphide filtrate was tested qualitatively for organic acids, and a turbidity formed on adding to the filtrate lime-water. It was not completely cleared by acetic acid.

Negative results followed tests with alcoholic methyl-violet solution for mineral acids. The *aqueous extract* contained no tannin. Calcium oxalate was determined in it.

Aqueous Maceration at a Temperature of 50° C. to 60° C.

The Bark of the Root (1), *the Wood of the Root* (2).

The powder (1) used in the cold water extraction was macerated with distilled water heated between 50° and 60° C. The *warm aqueous extract* (1) was cooled and mixed with three volumes of stronger alcohol. A precipitate formed, it was dried, weighed, and the percentage estimated. It yielded 0·03 per cent.* The precipitate

* The material used in this analysis of the green part of the leaf was quite dry and powdered readily. A previous examination of the *fresh leaves* gave more satisfactory quantitative results. A gum was extracted which promises to be of interest for a future study, and the crystals separated from the lead sulphide filtrate are to be further investigated

* *Examination for Inulin*, page 87, Plant Analysis, G. Dragendorff. English translation.

was dissolved in warm water. On evaporating the filtrate, a white residue was obtained. It was stained yellow by iodine.

The powder (2) from the cold water treatment was macerated in the warm water. The *warm aqueous extract* (2) was a dark coloured liquid, indicating a colouring matter. A certain measure of the *extract* was evaporated, and the solids estimated. It amounted to 4 per cent. The percentage of solids precipitated from the *extract* by stronger alcohol was 0·25 per cent.

(To be continued).

CORRESPONDENCE.

EXAMINATION OF OILS.

To the Editor of the Chemical News.

Sir,—In the article on the manufacture of butterine by Mr. Thomas T. P. Bruce Warren, which appears in the Chemical News, vol. lvi., p. 133, I observe that the author is apparently unaware that sesame oil is already largely employed in the manufacture of butter substitutes, which I suppose for the future we must call "margarine." In America, cotton-seed oil is doubtless the fluid oil chiefly employed for the purpose in question, but I believe this is not the case in Europe, where sesame oil and arachis oil seem to be preferred.

As Mr. Warren refers in his article to a communication on the "Adulteration of Oils," which he contributed to the Chemical News, vol. lv., p. 134, it may not be out of place to comment on some of the statements made in that paper, which otherwise lapse of time might induce me to pass over.

Mr. Warren commences his paper on the adulteration of oils by the statement that "with a few trifling exceptions all that appears from time to time in our chemical journals may be found in Chateau's "Corps Gras Industriels" (1864) and Fontenelle's "Manuel d'Huiles" (1866).

Among the methods of examining oils which Mr. Warren appears to class among "a few trifling exceptions" are the following:—

1. The process of determining the free fatty acids in oils by titration in alcoholic solution with phenol-phthalein as an indicator, as devised by Hausemann.
2. The method of ascertaining the saponification-equivalents of oils, devised by Koettstorpe.
3. The method of examining butter and similar fats containing glycerides of lower fatty acids, devised by Hehner.
4. The method of determining the volatile acids of butter and others, devised by Reichert.
5. The method of separating fatty and resin acids, invented by Gladding.
6. The determination of the bromine-absorptions of oils by Mills, and of iodine absorptions by Hübl.
7. The improved methods of determining the specific gravity of fats devised by Bell, Estcourt, and others.
8. The many quantitative determinations of the rise of temperature on treating oils with strong sulphuric acid in the manner described by Maumené.
9. The improved methods of determining glycerin, devised by Morawski, Muter, Benedikt, Fox, and others.
10. The determination of the higher alcohols in sperm and bottle-nose oils, and of hydrocarbon oils in fatty oils generally.

All, or near all, of the foregoing methods of examining oils have been devised or perfected within the last twenty years, and the majority of them within the last eight or ten, and hence could not have been described, or even foreshadowed, in books published in 1864 and 1866.

While apparently unaware of the enormous amount of work done, and the numerous quantitative results recorded by the chemists mentioned above, and by those who have employed their methods, Mr. Warren recommends the employment of chloride of sulphur as a qualitative test for oils. I had occasion to make some experiments with this reagent a few years since, but for another purpose than that of detecting or identifying any particular oil.

My experience of chloride of sulphur leads me to believe it to be badly adapted for such a purpose, as in my hands the extent and rapidity of its action on an oil varied in an obscure manner under conditions apparently identical. However, if Mr. Warren will prescribe definitely the method in which he prefers to employ chloride of sulphur as a reagent for oils, there are many chemists who, like myself, will be only too glad to give it a careful trial. Unfortunately, in his article he gives no such particulars as would enable other chemists to employ the reagent to the best advantage, and hence we look forward with interest to the publication by Mr. Warren of further information on the subject.—I am, &c.,

Alfred H. Allen.

Sheffield, Sept 24, 1887.

COLOURED FIRES.

To the Editor of the Chemical News.

Sir,—If "Practical Chemist" will refer to Kentish's "Pyrotechnist's Treasury" (London: Chatto and Windus) he will find no less than seventy-five formulæ for coloured fires which contain calomel.

Many, but not all, of these formulæ include also copper sulphide, and it is stated (p. 178) that the mercury salt is used as a source of chlorine, in which compounds of copper burn with a blue colour. The mercurous chloride is in these cases, no doubt, used, notwithstanding its cost, because of its superior stability and non-deliquescence, and because there is no solid residue as a product of its combustion.

It does not, however, seem quite clear why calomel should be used in the absence of copper, as in some of Kentish's formulæ and in that cited by your correspondent, but it is perhaps because of the intense light produced by the combustion of mercury at high temperatures.

The subject seems sufficiently interesting, and perhaps some practical pyrotechnist who is also a chemist will come to the rescue.—I am, &c.,

Harry Napier Draper.

Esterel, Temple Road, Upper Rathmines,
September 24, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 8, August 22, 1887.

Compressibility of Certain Solutions of Gas.—F. Isambert.—Very soluble gases, such as ammoniacal gas, give solutions which seem, by certain of their characters, to differ totally from true compounds. The author has sought to obtain new data on this question by a study of the physical properties of these solutions, and in the first place of their compressibility. He finds that a simple solution of gas alters little the coefficient of solubility of the solvent, and that the solution of ammoniacal gas in water behaves like the solution of a true chemical compound.

On the Zinc Titanates, and especially on a Tri-titanate.—Lucien Lévy.—Zinc trititanate is an acicular body, steel grey, inclining to a violet, of the sp. gr. 4·92 at 15°; insoluble in water, alcohol, and ether; infusible before the blowpipe. Heat transforms it, without loss of

weight, into a greenish mass. Hydrogen does not attack it at a red heat. Dilute sulphuric, hydrochloric, and nitric acids do not attack it, even in heat. Boiling sulphuric acid attacks it with difficulty. Strong boiling alkalies have no action; melting potassa attacks it; acidified hydrogen peroxide takes a characteristic yellow colour on contact with this compound, but the attack is never complete.

No. 9, August 29, 1887.

Projection-Saccharimeter. — Leon Laurent. — The construction of this instrument cannot be made intelligible without the accompanying diagram.

Experiments in Agricultural Chemistry.—J. Raulin. —The author considers that the results of comparative trials in agriculture are almost always disturbed by the influence of the unequal fertility of the soil at different points. This influence is sometimes as great as that of the conditions to be studied. To avoid this cause of error the experiments at the agronomic station of the Rhone are arranged as follows:—The rectangular experimental field is divided into as many rectangular plots, equal and parallel, as there are conditions to be studied. Each of these plots is divided into three equal squares, A, B, C. The two extreme squares, A and C, are treated identically, whilst B serves as a check. In general the natural fertility of the soil presents differences from A to C. If they are absolutely irregular the ground is not fit for comparative trials. But more commonly the fertility increases or decreases regularly from A to C, so that half the sum of the crops of A and C would be equal to the crop of B, if all three were similarly treated. The cause of error due to the inequality of the soil is thus chiefly eliminated, and the proportion of the crop of $\frac{A+C}{2}$ to that of B expresses the real influence of the manure or other condition which is being studied.

MISCELLANEOUS.

King's College, London.—Lectures on Agriculture. —A Course of about Eighteen Lectures will be delivered on "Agriculture" during the ensuing Winter Session, by Mr. Frederick James Lloyd, F.C.S., F.I.C., Consulting Chemist to the British Dairy Farmers' Association, beginning Friday, October 14, from 6 to 7 p.m. Fee for the Course £2 2s., payable in advance in the College Office. *Syllabus*:—Soils: Composition and Properties of Soils; The Atmosphere and Soil as Plant Food; Cultivation of the Soil; Improvement of the Soil Drainage, Subsoiline, &c. Manures: Farmyard Manure and its Treatment; Artificial Manures, their Composition and profitable Application. Crops: Chemistry and Physiology of Plant Life; The Rotation and Treatment of the principal Farm Crops; The Composition and value of Agricultnral Produce. Live Stock: Chemistry and Physiology of Animal Life; The Rearing and Management of Live Stock; The Production of Animal Food; Dairy Management and Produce. The Lectures will be especially adapted to prepare Students for the Examinations of the Royal Agricultural Society, and of the Surveyors' Institute.

ERRATUM.—In the summary of the classes at the Manchester Technical School, in our last issue, the second year's course of lectures should have read "Lectures upon the *rarer* metals," &c.

UNIVERSITY COLLEGE, LIVERPOOL.

The SHERIDAN MUSPRATT CHEMICAL SCHOLARSHIP, of the value of £50 per annum, tenable for two years, is awarded after an Examination commencing on December 8th, and is open to any Candidates under 23 years of age.

If a second Candidate possesses sufficient merit an Exhibition of £25, for one year, will likewise be awarded.

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E. LONDINI, Registrar.

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NEXT SESSION BEGINS OCTOBER 4th.

Full particulars can be obtained from the Registrar, Normal School of Science, South Kensington, and Prospectuses at the Catalogue Sale Stall of the South Kensington Museum.

THE MASON COLLEGE, Birmingham.

SESSION 1887-88.

FACULTIES OF ARTS AND SCIENCE.

The NEXT SESSION commences on MONDAY, October 3rd.

No Student will be admitted under the age of 16 without having passed a Preliminary Examination.

SYLLABUSES, containing complete information as to the various Courses of Instruction, Fees, Lecture Days and Hours, Entrance and other Scholarships, Prizes, &c., may be obtained from CORNISH BROS., New Street, Birmingham, price 3d., by post 4½d.

GEO. H. MORLEY, Secretary.

UNIVERSITY COLLEGE, BRISTOL.
CHEMICAL DEPARTMENT.

PROFESSOR—SYDNEY YOUNG, D Sc.
LECTURER—ARTHUR RICHARDSON, Ph.D.

The SESSION 1887-88 begins on 4th OCTOBER. Lectures on Inorganic, Organic, Advanced, and Photographic Chemistry will be delivered during the Session. The Laboratories are fitted with the most recent improvements for the study of Practical Chemistry in all its branches. In the evening Lectures on Inorganic Chemistry and on Photographic Chemistry at reduced fees are delivered. There will also be a Course of Lectures on the Chemistry of Every-day Life. Several Scholarships are tenable at the College. Calendar, containing full information, price 1s. (by post 1s. 3d.). For Prospectus and further information apply to the Registrar.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE.

DEMONSTRATOR AND ASSISTANT LECTURER IN CHEMISTRY. Stipend £120 a year.

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The above appointments are now vacant. Applications, together with testimonials, must be sent in on or before Saturday, October 8th, 1887, to the undersigned, of whom all further particulars may be obtained.

IVOR JAMES,
Registrar.

Cardiff, September 6, 1887.

SALT ROYALTY.

TO LET.—The Owners of the Middlesbrough Estate, Limited, are prepared to receive offers, or enter into negotiations for working, the Bed of Rock Salt which has recently been proved to be under the Company's Estate, 90 feet in thickness, at a depth from the surface of 1340 feet. The site of the Bore-hole which has been sunk is in close proximity to the Guisbrough Branch of the North-Eastern Railway, and within a short distance of the Middlesbrough Docks and the River Tees. There are several acres of land adjoining, suitable for the erection of Works.

For further particulars apply to the General Manager, The Owners of the Middlesbrough Estate, Limited, Queen's Square Middlesbrough.

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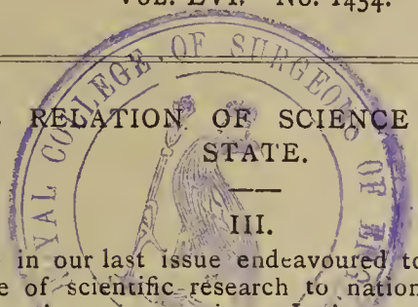
LABORATORY.—Wanted Immediately, Laboratory for Technical Research for two to work in. Will be required for a month or more.—Apply to V. J., Ashurst, West Hill, Sydenham.

THE CHEMICAL NEWS.

VOL. LVI. No. 1454.



THE RELATION OF SCIENCE TO THE STATE.

III.

HAVING in our last issue endeavoured to show the importance of scientific research to nations, we have to encounter the main questions—Is the present position of Science in the United Kingdom satisfactory? and if not, why not? To the former of these queries scarcely anyone has the boldness to reply in the affirmative. Were all well with us in this respect, why that feeling of dissatisfied excitement rarely felt on any subject which does not fall within the programme of faction? Why do we send out commissions to scrutinise the state of scientific and technical education in Continental countries? Why do we institute new colleges and training schools of different grades, and why propose, as it has been lately done, new Parliamentary action in this direction? Why do we hear complaints made, not merely at the gatherings of purely scientific bodies, but among men of business, that in this important respect and in comparison with rival nations we are not holding our own, not to speak of gaining ground?

That along with this feeling of discontent and this craving for improvement there is an undercurrent of indifference, or even of hostility to Science, is but too true. Why, else, should Sir Henry Roscoe, in his late presidential address before the British Association, remark that Science was less respected in Britain than in other civilised countries? Or how could a well-informed German contemporary take occasion to say that Britain had, whichever party happened to be in power, "a Government very unfavourably disposed to Science and to her disciples"? ("Eine der Wissenschaft und ihren Jüngern sehr abhold gesinnte Regierung)".

In fact, notwithstanding all that has been done of late years, all the efforts made, and all the money expended, many of the complaints urged in Babbage's "Decline of Science" still hold good. It can no longer, indeed, be said that there is in all the universities of Britain not a single person engaged in any train of original research. We recognise with pleasure that experimental Science has obtained a footing in our ancient seats of learning, and that fairly efficient laboratories—chemical, physiological, and biological—have been or are being organised. Whether these institutions, when compared with those met with abroad, *e.g.*, at the University of Strasburg, are fairly commensurate with the importance of their task and with the wealth of the country, is another question.

But we have still to complain of the paucity of research issuing from the British Universities. We have tilled and manured the soil, and scattered the good seed, but the harvest, so far, is of the scantiest. We take up some German chemical journal, say a number of *Liebig's Annalen* or the *Journal für Praktische Chemie*, and looking down the table of contents we see such headings as these—"Communications from the Chemical Laboratory of the University of Leipzig, of Bonn, of Würzburg," &c., thus showing that in these institutions original research is being actively and successfully conducted. We single out here chemistry both as being, in our belief, the most important of the Sciences, and as being our special and immediate subject. But in the other Sciences the case is the same: every German, Austrian, Swiss, even Russian university is a copious well of scientific truth, not a mere cistern in which such truth is stored up. Now can we present any similar spectacle in Britain? Can we, *e.g.*, in the CHEMICAL NEWS, lay before our readers every few months a summary of chemical researches carried on in the Universities of Oxford, Cambridge, Edinburgh, Glasgow, or Dublin?

But it may, perhaps, be thought that if original research does not flourish as it ought in our universities, it finds other channels. What of our numerous learned societies, and of the papers sent for insertion to our scientific journals? Here we may boast of a goodly amount of work done, some of which is unsurpassed in value. But in quantity it must, we fear, be admitted that we cannot stand the test of a comparison with Germany. Confining ourselves here to chemistry, we see the *Berichte* of the German Chemical Society issued yearly in not fewer than twenty parts, each of which contains on an average forty original memoirs. There are, in addition, *Liebig's Annalen*, the *Journal fur Praktische Chemie*, entirely filled with original matter, and a number of other Journals, which, along with abstracts and articles on various branches of technical chemistry, bring forward no small quantity of original research.

It will be said that the German Journals aforesaid receive their matter not merely from the German Empire, but from Sweden, Holland, Belgium, Austria, Russia, and even to some extent from England. Precisely; but wherefore do non-German *savants* thus select German Journals and Transactions as the channel for their discoveries? Very rarely are English Journals thus favoured. The reason, surely, is not hard to divine. Many scientists in all parts of the world have been trained in the German Universities, or have studied in their own countries under German Professors. But how many aliens flock to Britain to study in our universites? How many Englishmen are called to fill professorial chairs in foreign countries? Nay, under present circumstances we seem unable to produce competent men in sufficient numbers for scientific professorships in the Colonies, in India, and even at home. The number of aliens who thus occupy prominent positions in our colleges, museums, observatories, &c., is nothing short of a national stigma, and is alone sufficient to demonstrate the unsatisfactory position of Science among us.

The number of scientific works which issue from the British press is also no satisfactory feature. With the exception of translations, and of manuals and cram-books, we are not fertile. In the latter department we are, by way of contrast, only too rich.

Another proof of our shortcomings may be found in the rarity of our scientific exploring expeditions, by land or by sea. Since the memorable voyage of the *Challenger* nothing of an extensive systematic character has been undertaken either under the auspices of Government or of private individuals. Nor must we forget that the staff of the *Challenger* was in part recruited abroad, and that the collections made and other crude results obtained were not entirely worked out at home. Some of them were committed for this purpose to Prof. Bary, of the University of Strasburg.

The last, and certainly not the weakest, evidence of the state into which we have allowed ourselves to fall is the continued influx of foreigners into the laboratories of our chemical manufactories. Exact statistics on this point do not seem to be procurable; but as far as the observation of individuals can reach, these foreigners are continually increasing in number. About the year 1858 there was, to the best of our knowledge, only one foreign chemist employed in the great alkali district of south-west Lancashire; now, we believe, they are more numerous than native chemists. At the risk of a momentary digression we may pronounce it singular and unfortunate that such an increase should have been effected in the very teeth, so to speak, of the Science and Art Department, with its great powers and its lavish expenditure.

TORSION BALANCES.*

By Dr. A. SPRINGER.

Light frames are made and stiffened by wires or flat bands being tensioned over them. The beam is then firmly clamped to the bands in such a manner that its centre of gravity is above its point of support; this tends to tip the beam, thus equilibrating the torsional resistance of the fulcrums. We thus have the torsional resistance exerted to keep the beam horizontal, and the high centre of gravity tends to tip it out of the horizontal.

The adjustment of the position of the centre of gravity is most easily made by having an adjustable poise placed immediately above the centre of the torsional wire. In order to do away with the necessity of alignment of support a secondary beam is attached to the first in such a manner that both beams tending to tip in the same direction remain stationary owing to their having opposite and equal moments.

On this principle, scales are constructed which can be used on rolling ships or in buildings where there is considerable jarring. In all the "Torsion Balances" there is permanence of adjustment, consequently repeated weighings will give like results.

Various "Torsion Balances" were shown illustrating the principles involved, as well as to show how equal sensitiveness can be obtained with any load.

APPARATUS FOR MEASURING THE VOLUME OF GAS INVOLVED IN VARIOUS CHEMICAL ACTIONS, WITH OR WITHOUT THE APPLICATION OF HEAT,

With Proposed Extension to Organic Analysis, and to the Continuous Determination of Abnormal Vapour Densities.*

By F. W. WATKIN, M.A.

The apparatus consists of generating tubes, flasks, and U measuring tubes, in direct communication with the generating tubes; the measuring tubes contain water, and readings are taken with the water at the same level in the two branches of each U-tube, so that the readings are all at the barometric pressure. To correct for change of temperature, if at the time of making the final readings the temperature of the room should not be the same as at the time of the initial readings, by the side of the generating tube flasks, measuring tubes, &c., an exactly similar piece of apparatus is placed, consisting of tube, flasks, measuring tubes, &c., and having approximately the same volume as the original piece of apparatus.

The process employed was shown at the meeting of the Association, and the proposed method of application to organic analysis, by which CO_2, H_2O, and N may be concurrently determined, and to abnormal vapour densities, was explained with the assistance of diagrams.

ON SOLUTION.*

By WILLIAM DURHAM, F.R.S.E.

The object of this paper is to show that thermo-chemical results accumulated of late years entirely support the theory of solution which the author brought forward in a paper read before the Royal Society of Edinburgh in January 1878, and developed in subsequent papers.

That theory may be briefly described as follows. Solution is due to the chemical affinity of the elements of the substance dissolved for the elements of the solvent. For instance, common salt, Na_2Cl_2, dissolves in water because of the affinity of Na_2 for O and of Cl_2 for H_2. Further, chemical affinity is not in all cases exhausted when definite compounds are formed, but sufficient remains to form what may be called "solution compounds."

In support of this view it is pointed out that in all chlorides, bromides, iodides, sulphates, and nitrates for which data are available the heat of solution *varies directly*—

(1) As the heat of combination of the positive element of the salt with O in water varies.

(2) As the heat of combination of the negative element of the salt with H varies. And *inversely*—

(3) As the heat of combination of the positive and negative elements of the salt varies. Examples are given, such as the following:—

Compound.	Heat of Combination.	Difference.	Heat of Solution.	Difference.
[Mg,Cl$_2$] ..	151010		35920	
[Mg,O,Aq] ..	148960			
		2050		
[Ca,Cl$_2$] ..	169820		17410	
				+18510
[Ca,OAq] ..	149260			
		20560		
		−18510		+18510
[Na,Cl]	97690		−1180	
[H,Cl,Aq] ..	39315			
		58375		
[Na,Br]	85770		−190	
				−990
[H,Br,Aq] ..	28380			
		57390		
		+985		−990

The author further shows that if we take two salts, say chlorides, in one of which the heat of combination is greater than in the other, we find that the difference appears in the increased heat of solution of the latter, modified by the difference of affinities of the metals for O; as for example:—

Difference of Heats of Combination.		Difference of Heats of Solution.
[K$_2$,Cl$_2$] − [Li$_2$,Cl$_2$]	= 23600	[Li$_2$,Cl$_2$] − [K$_2$,Cl$_2$] = 25760
[Li$_2$,O,Aq] − [K$_2$,O,Aq]	1960	
	25560	25760

Also in comparing chlorides with bromides it is found that the excess of heat of combination of the two salts over that of their respective acids varies inversely as the heat of solution of the two salts; thus—

Difference of Heats of Combination.		Difference of Heats of Solution.
[Ba,Cl$_2$] − [H$_2$,Cl$_2$,Aq]	116110	[Ba,Br$_2$] − [Ba,Cl$_2$] 2910
[Ba,Br$_2$] − [H$_2$,Br$_2$,Aq]	113200	
	2910	2910

Finally, by taking pairs of any salts, every consideration but heats of combination on the one side and heats of solution on the other can be eliminated; and it is evident the heats of solution just vary inversely with the heats of combination; as, for instance—

Difference of Heats of Combination.		Difference of Heats of Solution.
[Mg,S,O$_4$] − [Mg,Cl$_2$]	151300	−15640
[Zn,S,O$_4$] − [Zn,Cl$_2$]	132860	+ 2800
	+18440	−18440

In considering how the absolute amount of heat of solution arises, the author shows that it seems to be due to a balancing of affinities among the constituent elements, and that when, for instance—

$$[M,Cl_2] - \{[M,OAq] + \text{Neutr.}\}$$

* Read before the Chemical Section of the British Association, Manchester Meeting.

is equal to $[H_2,Cl_2,Aq]-[H_2,O]$ there is no heat of solution, and the salt is insoluble. Several examples of chlorides and other salts are given. It would appear also that when an oxide is neutralised by an acid solution, and the salt remains in solution, the operation is not complete; either the oxide and the acid are not completely decomposed when we have positive heat of solution, or, on the other hand, the salt and water resulting from the double decomposition are not completely formed when we have negative heat of solution. When both parts are complete we have insolubility. Several examples are given to show this. It is also pointed out in this paper that in the case of sulphates, when the heat of combination of the oxide with sulphuric anhydride is equal to the heat of combination of the metal with sulphur, there is no solubility, but when the former is less than the latter solution immediately appears; thus—

$[SrO,SO_3]$ =99220 [Sr,S] =99220 Salt insoluble.
$[CaO,SO_3]$ =84200 [Ca,S] =92000 Salt slightly soluble.
$[MgO,SO_3]$ =53070 [Mg,S]=79660 Salt very soluble.

The author finally draws attention to the fact that solution is probably a periodic function of the elements.

THE MATRIX OF THE DIAMOND.*

By Professor H. CARVILL LEWIS.

A MICROSCOPICAL study of the remarkable porphyritic peridotite which contains the diamonds in South Africa, demonstrates several interesting and peculiar features.

The *olivine*, forming much the most abundant constituent, is in porphyritic crystals, sometimes well bounded by crystal faces, at other times rounded and with corrosive cavities, such as occur in it in basaltic rocks. It rarely encloses rounded grains of glassy bronzite, as has been observed in meteorites. The olivine alters either into serpentine in the ordinary way, or into an aggregate of acicular tremolite crystals, the so-called "*pilit*," or becomes surrounded by a zone of indigo blue bastite—a new variety of that substance. The olivine is distinguished by an unusually good cleavage in two directions.

Bronzite, *Chrome diallage*, and *Smaragdite* occur in fine green plates, closely resembling one another. The bronzite is often surrounded by a remarkable zone, with a centric, pegmatitic, or chondritic structure, such as occurs in certain meteorites. This zone is mainly composed of wormlike olivine grains, but a mineral having the optical characters of cyanite also occurs in this zone.

Biotite, a characteristic constituent, occurs in conspicuous plates, often twinned, generally rounded, and distinguished by its weak pleochroism, a character peculiar to the biotite of ultra-basic eruptive rocks. It alters by decomposition into the so-called *Vaalite*.

Perovskite occurs in very numerous but small crystals, which optically appear to be compound rhombic twins.

Pyrope is abundant in rounded red grains. Titanic iron, chromic iron, and some fifteen other minerals were also found. Rutile is formed as a secondary mineral through the alteration of olivine into serpentine, being a genesis of rutile not heretofore observed.

The *chemical composition* shows this to be one of the most basic rocks known, and is a composition which by calculation would belong to a rock composed of equal parts of olivine and serpentine, impregnated by calcite.

The *structure* is at the same time porphyritic and brecciated, being one characteristic of a volcanic rock which, after becoming hard, had been subjected to mechanical movements. It is a volcanic breccia, but not an ash or tuff, the peculiar structure being apparently due to successive paroxysmal eruptions. A similar structure is known in *meteorites*, with which bodies this rock has several analogies. A large amount of the adjoining bituminous shale is enclosed, and has been more or less baked and altered. The occurrence of minute tourmalines is evidence of fumarole action.

The microscopical examination supports the geological data in testifying to the igneous and eruptive character of the peridotite, which lies in the neck or vent of an old volcano.

While belonging to the family of peridotites, this rock is quite distinct in structure and composition from any member of that group heretofore named. It is more basic than the picrite porphyrites, and is not holocrystalline like dunite or saxonite. It is clearly a new rock type, worthy of a distinctive name. The name *Kimberlite*, from the famous locality where it was first observed, is therefore proposed.

Kimberlite probably occurs in several places in Europe, certain garnetiferous serpentines belonging here. It is already known at two places in the United States: at Elliott County, Kentucky, and at Syracuse, New York; at both of which places it is eruptive and post-carboniferous, similar in structure and composition to the Kimberley rock.

At the diamond localities in other parts of the world diamonds are found either in diluvial gravels or in conglomerates of secondary origin, and the original matrix is difficult to discover. Thus, in India and Brazil the diamonds lie in a conglomerate with other pebbles, and their matrix has not been discovered. Recent observations in Brazil have proved that it is a mistake to suppose that diamonds occur in itacolumite, specimens supposed to show this association being artificially manufactured. But at other diamond localities, where the geology of the region is better known than in India or Brazil, the matrix of the diamond may be inferred with some degree of certainty. Thus, in Borneo diamonds and platinum occur only in those rivers which drain a serpentine district, and on Tanah Laut they also lie on serpentine. In New South Wales, near each locality where diamonds occur, serpentine also occurs, and is sometimes in contact with carboniferous shales. Platinum, also derived from eruptive serpentine, occurs here with the diamonds. In the Urals, diamonds have been reported from four widely separated localities, and at each of these, as shown on Murchison's map, serpentine occurs. At one of the localities the serpentine has been shown to be an altered peridotite. A diamond has been found in Bohemia in a sand containing pyropes, and these pyropes are now known to have been derived from a serpentine altered from a peridotite. In North Carolina a number of diamonds and some platinum have been found in river sands, and that State is distinguished from all others in eastern America by its great beds of peridotite and its abundant serpentine. Finally, in northern California, where diamonds occur plentifully and are associated with platinum, there are great outbursts of post-carboniferous eruptive serpentine, the serpentine being more abundant than elsewhere in North America. At all the localities mentioned chromic and titanic iron ore occur in the diamond bearing sand, and both of these minerals are characteristic constituents of serpentine.

All the facts thus far collected indicate *serpentine*, in the form of a decomposed eruptive peridotite, as the original matrix of the diamond.

* Read before the Section C of the British Association, Manchester Meeting.

AN ELECTROLYTIC METHOD OF PREPARING METALLIC ALLOYS, &c.

By H. WARREN, Research Analyst.

THE following method of preparing metallic alloys, such as silicides, bronzes, &c., has lately been satisfactorily wrought by the following process, which differs slightly from the manner in which mercury amalgamates or combines with mostly all other elements, owing to its

liquidity. By substituting for the mercury, iron, copper, zinc, &c., these metals may be readily made to combine with the more oxidisable elements, such as silicon, phosphorus, &c., by so arranging the process that the metal employed for forming the alloy, when in a fluid state, is connected with the negative pole of a voltaic series, and in direct contact with the substance containing the element with which it is desired to combine it.

The apparatus employed consists of a deep conical crucible, through the bottom of which is inserted a pointed graphite rod, projecting about an inch within; the remaining portion being protected by passing through an iron tube coated with borax to prevent oxidation when exposed to a furnace heat. The extremity is furnished with a binding-screw or clamp, and connected with the negative pole of the batteries employed, the whole arrangement being heated to the melting-point of the metal employed to form the alloy by the aid of a small furnace. Taking, for instance, the preparation of silicon bronze: having introduced a sufficient quantity of metallic copper into the crucible, add sufficient potassium silico-fluoride to form when melted a layer about 2 inches in depth. A thick platinum wire is arranged so that its point just touches the surface of the melted silico-fluoride (care being taken that the melted copper remains sufficiently low so as not to come in contact with the positive pole or platinum wire, otherwise the action is of course neutralised and the power of the batteries uselessly exhausted). This wire is connected to the positive pole of two large cells of the ferric chloride battery, when an instantaneous action is at once perceptible; dense white vapours of hydrofluoric acid are at once evolved from the platinum wire, the potassium silico-fluoride becomes entirely decomposed, and the whole of the silicon when in a nascent state unites with the metallic copper to form a brittle silicide, which may be converted at once into silicon bronze by the usual method, according to the percentage of silicon present.

Phosphor and other bronzes may also be readily formed by slight alteration.

For the preparation of silicon-eisen the substitution of iron in place of copper is all that is required; the silicon-eisen so employed presents the appearance of ordinary hot-blast silicide.

Native cryolite may also be readily decomposed when in contact with metallic zinc, and by suitable means the zinc may be volatilised, leaving pure aluminium.

Magnesium, and the earthy metals, barium, strontium, and calcium, have as yet not been satisfactorily obtained as alloys.

ON THE

COMPONENTS OF THE RARE EARTHS GIVING ABSORPTION-SPECTRA.

By GERHARD KRÜSS and L. F. NILSON.

(Continued from p. 147).

II.

As mentioned in the first portion of this memoir, even during the investigation of the thorite earths, the conjecture occurred to the authors that bodies like Soret's X, thulium, and the present erbium, are not simple chemical elements. In the last decennium the old erbia was supposed to be the oxide of a simple element. We know now that this erbia consists of seven earths,—scandia, ytterbia, thulia, erbia, terbia, Soret's X, and yttria.

From the observations communicated in this memoir the authors consider that they can show with great probability that even those erbium earths whose nitrates give absorption-spectra are not simple bodies, but mixtures of the oxides of different elements. As this is most distinctly perceptible if we follow out the occurrence or the absence of the single holmium lines in the spectra examined, the authors report in the first place:—

1. *On the Components of Holmium, or of Soret's* X.

The nitrate of X, or holmium nitrate as it is termed by Clève, gives, according to Soret's measurements, the following absorption-lines in the clearly visible part of the spectrum:—

λ 753 faint.
640·4, 536·3 } very characteristic.
485·5
474·5 very faint and misty.
453—449.
430 doubtful.

Instead of λ=430·0, Lecoq de Boisbaudran found λ=427·5. The authors found, almost without exception, λ=428·5, which value is accordingly inserted in the foregoing Tables. This line has been repeatedly characterised formerly as an absorption-line of didymium, and has been inserted in didymium spectra. This is because both didymium and holmium are compound bodies, and their single components may occur together. We may name this band λ=428·5, or preferably one of the bands peculiar to X, for it always occurs on examining a holmium material obtained after several hundred decompositions of the mixed nitrates, and which otherwise contains none of the bands hitherto assigned to Di. Such a material is perfectly free from all didymium earths.

It was further observed that at λ=542·6 a band was almost always visible, such as was otherwise found in the spectrum of the holmium lines; λ=542·6 was recognised in the thorites of Arendal, in the Fergusonites of Ytterby and Arendal, in the euxenites from different localities, and in mother-liquors from different minerals. The substance to which this line belongs always follows in those fractions which are becoming richer in holmium; whence for the present we designate this band, like the other holmium lines, by the symbol X.

Lecoq de Boisbaudran made it known last year that, by means of several hundred fractionations of a holmium material with ammonia and potassium sulphate, he had resolved Soret's X into two elements, holmium—properly so called—and dysprosium. The spectrum of *this* holmium nitrate showed the bands λ=640·4 and 536·3 very strongly and the other X lines faintly, whilst dysprosium nitrate showed the other bands of the holmium spectrum more distinctly. Lecoq de Boisbaudran designates the bands of dysprosium, according to the order of their intensities, as—

Dy α..	λ=451·5
Dy β..	λ=475·0
Dy γ..	λ=756·5
Dy δ..	λ=427·5.

As it appears from the above Table holmium is no unitary body, but it consists of more than two components, de Boisbaudran's holmium and dysprosium are also compound bodies.

If we next consider the spectrum of the earths obtained from the thorite of Brevig, it appears that of all the X lines only that at λ=428·5 was recognised as strong, whilst λ=640·4 and 685 5 appeared very faint; λ=428·5 is the fourth faintest line of the dysprosium spectrum, and is designated by Boisbaudran as Dy δ. If dysprosium nitrate is the nitrate of a unitary body, then if Dy δ is strongly visible (as it is in the spectrum of the Brevig thorite), Dy γ, Dy β, and Dy α must appear the stronger in the spectrum. But this was not the case; X lines could be recognised neither at λ=451·5, nor at 475·0, nor 756·5. The so-called dysprosium consists therefore of at least two bodies, to one of which there belongs (in the nitric solution) only the band λ=428·5, whilst the other produces absorptions at λ=451·5, 475·0, and 756·5. As these lines were not observed in the material from the Brevig thorite, this portion of de Boisbaudran's dysprosium does not occur in this mineral. Likewise, in a didymium material obtained from the cerite of Bastnäs only Dy δ=428·5 was observed of all the lines peculiar to Dy.

Here, therefore, Nature has undertaken the separation of that portion of de Boisbaudran's dyprosium, the presence of which, in the mixture known as Soret's X, occasioned the appearance of the absorption-line at $\lambda=428{\cdot}5$ in the holmium spectrum.

Further, de Boisbaudran's Dyβ line, at $\lambda=475{\cdot}0$, was observed in the material precipitated by potassium sulphate from the solutions of the thorite earths from Arendal, as well as in the mother-liquors obtained in the preparation of pure ytterbia (Series 41—46). But the Dyα line, which should appear stronger if Dyα and Dyβ belong to a unitary body, could not be perceived. That $\lambda=475{\cdot}0$ and $451{\cdot}5$ belong to different bodies appears further from the fact that in the spectra of the fractions obtained from the euxenite of Arendal $\lambda=474{\cdot}5$ rapidly decreases in intensity from Fraction V. to X., and at last entirely disappears, whilst $\lambda=453$—449 (Dyα) was observed extremely strong, as the strongest line in the entire spectrum. $\lambda=474{\cdot}5$ belongs to a nitrate which contains an oxide less basic than the nitrate to which $\lambda=451{\cdot}5$ belongs. The latter seems to occur completely separated from the former, and in relatively large quantities, in the Fractions XI., XII., and XIII., from the euxenite of Arendal. Lecoq de Boisbaudran's lines Dyα, Dyβ, and Dyδ belong therefore to three distinct elements.

As for the X line $\lambda=485{\cdot}5$ it was observed faintly, but certainly, in the spectrum of the thorite of Brevig, and in those of the mother-liquors obtained in preparing ytterbia, whilst the X (or Dy) lines at $\lambda=474{\cdot}5$ and $451{\cdot}5$, or at $\lambda=451{\cdot}5$ and $428{\cdot}5$, could not be seen. The X lines also $\lambda=542{\cdot}6$ and $536{\cdot}3$ were not visible in the spectrum of the Brevig thorite, though $\lambda=485{\cdot}5$ was recognised. If we further consider that $\lambda=485{\cdot}5$ appeared somewhat strongly in the Fractions VI. to IX. of the fergusonite of Arendal, without $\lambda=640{\cdot}4$, $474{\cdot}5$, and $428{\cdot}5$ being visible, it appears that the occurrence of this X line is not necessarily accompanied by that of any other X line, and that the body whose presence occasions the line $\lambda=485{\cdot}5$ must exist in the different minerals and fractions examined, in part separated from the other components of Soret's X.

As regards holmium in the stricter sense of the word, its nitrate gives, according to Lecoq de Boisbaudran, principally only two bands at $\lambda=640{\cdot}4$ and $536{\cdot}3$. But this true holmium must at least consist of two elements, for $\lambda=640{\cdot}4$ was observed in the spectra of thorite of Brevig and in those of the cerite of Bastnäs, certainly though faintly, whilst $\lambda=536{\cdot}3$ was not present. On the other hand, in the spectra of the yttria earths from the thorite of Arendal, in that of wœhlerite, of fergusonite from Arendal, and in the first fractions of euxenite from Arendal, the line $\lambda=536{\cdot}3$ was in part strongly visible without the least indication at $\lambda=640{\cdot}4$ of the element producing this line.

In fine, it is evident that the X line at $\lambda=542{\cdot}6$ was observed without the simultaneous recognition of—

- $\lambda=428{\cdot}5$ (see fergusonite from Arendal, Fractions V. to XI., and mother-liquors from the ytterbia earths, Series 41 to 46).
- $\lambda=453$—449 (see euxenite from Hitterö, Fractions I. and II., and ytterbia mother-liquors, Series 41 to 46).
- $\lambda=474{\cdot}5$ (see fergusonite from Arendal, Fractions VI. to XI.).
- $\lambda=485{\cdot}5$ (see yttria earths from the thorite of Arendal; euxenite from Hitterö, Fractions I. to IV.; euxenite from Arendal, Fractions. I. and II·).
- $\lambda=536{\cdot}3$ (see fergusonite of Arendal, Fractions X. and XI.; euxenite from Arendal, Fractions XIII. and XIV., and ytterbia mother-liquors, Series 41 to 46).
- $\lambda=640{\cdot}4$ (see yttria earths from the thorite of Arendal, fergusonite, some fractions of the euxenite from Arendal, and ytterbia mother-liquors, Series 41 to 46). If the line $\lambda=542{\cdot}6$ actually occurs together with all other X lines (as, *e.g.*, in the fractions of euxenite from Hitterö, or in the spectrum of the holmium material) it appears relatively very weak.

So much the rather must the other X lines, or one of them, always be visible along with $\lambda=542{\cdot}6$ if this line along with another X line was produced by the absorption of a unitary body. But as this is not the case, and as the appearance of $\lambda=542{\cdot}6$ is not connected with the visibility of any other of the X lines, we must ascribe this to the nitrate of a particular element which has the property in common with the other components of holmium that its nitrate has an absorption-spectrum of one line only.

The authors do not, for the present, propose to give especial names to the several components of Soret's X. We abandon the name dysprosium since it denotes merely a compound body. The same holds good with regard to holmium, the more because Clève applies it to the entire X of Soret, whilst Lecoq de Boisbaudran uses it only for a portion of the former. They propose to retain the original name X for Soret's earth, and to distinguish its components as follows:—

Symbol.	Characteristic Line in the Absorption-Spectrum of the Nitrate Solution. λ
Xα	640·4
Xβ	542·6
Xγ	536·3
Xδ	485·5
Xε	474·5
Xζ	451·5
Xη	428·5

There occur in Nature in:—

Minerals.	The Elements.
Thorite of Brevig	Xα, Xδ, Xη
Thorite of Arendal	Xβ, Xγ, Xε, Xζ, Xη
Wœhlerite of Brevig	Xγ, Xζ, Xη
Cerite of Bastnäs	Xα, Xη
Fergusonite of Arendal	All except Xα
Fergusonite of Ytterby and Euxenite of Hitterö and Arendal	All the components.

2. *On the Components of Erbium.*

It having been ascertained about ten years ago that erbium, in the old sense of the word, is a complex body, the name erbium has been applied to a body whose nitric solution, besides a great number of absorption-bands situate in the violet and ultra violet, shows particularly two lines in the visible portion of the spectrum: —

$$Er_\alpha \text{ at } \lambda=523{\cdot}1 \text{ and } Er_\beta \text{ at } \lambda=654{\cdot}7.$$

The former of these lines has been considered as more intense than the latter. The authors give a conspectus of the relative intensities of these two erbium lines in the spectra of the minerals and fractions examined. (See Table next page).

From numbers 1 to 4 of this Table it is evident that the relative intensities of the two erbium bands was found as it has been hitherto given by other authors, $\lambda=523{\cdot}1$, appearing always rather stronger than $\lambda=654{\cdot}7$. It is, however, striking that on examining the holmium material both bands were seen about equally bright. It is still more striking that in the spectra of the thorite of Brevig, of fergusonite of Ytterby, and of the euxenite of Hitterö, the difference between the intensities of the two erbium bands is much greater than in the spectra of the first-mentioned minerals.

If the spectra of the Fractions IV. to VII. of the euxenite of Arendal, $\lambda=523{\cdot}1$, appears very strong, and $\lambda=654{\cdot}7$ strong, then in the spectrum of Fraction I. of the euxenite of Hitterö, in which $\lambda=523{\cdot}1$ is seen extremely strong, $\lambda=654{\cdot}7$ should be found strong or very strong if we have in erbium nitrate (which yields these lines) the nitrate of a chemical element. But this is not the case, since in Fraction I. of the Hitterö euxenite $\lambda=654{\cdot}7$ appears not strong, but extremely weak. We must, therefore, suppose erbium as composed of at least

In the Spectrum of Earths from.	Relative Intensities of Erbium Lines. $\lambda = 654{\cdot}7$.	$\lambda = 523{\cdot}1$.
1. Thorite from Arendal, yttria earths	Rather strong.	Strong.
2. Wœhlerite from Brevig	Rather strong.	Strong.
3. Fergusonite from Arendal: Fract. II. and III. ..	Strong.	Very strong.
3. Fergusonite from Arendal: „ VI., VII., VIII.	Rather faint.	Rather strong.
3. Fergusonite from Arendal: „ XII.	—	Very faint.
4. Euxenite from Arendal: Fract. I.	Rather strong.	Strong.
4. Euxenite from Arendal: „ IV. to VII.	Strong.	Very strong.
4. Euxenite from Arendal: „ X. to XII.	Rather strong.	Strong.
5. Holmium material	Faint.	Faint.
6. Thorite from Brevig	Faint.	Strong.
7. Fergusonite from Ytterby	Rather strong.	Very strong.
8. Euxenite from Hitterö: Fract. I.	Extremely faint.	Extremely strong.
8. Euxenite from Hitterö: „ II. to VI.	Extremely faint.	Strong.
8. Euxenite from Hitterö: „ VII. to XLIII. ..	Extremely faint.	Decreasing from rather strong to extremely faint.
9. Mother-liquors from the erbia earths series 54—60	Very faintly visible.	—

two elements,—the nitrate of the one giving the band $\lambda = 654{\cdot}7$, that of the other $\lambda = 523{\cdot}1$. The former body the authors name Er_α ($\lambda = 654{\cdot}7$) and the latter Er_β ($\lambda = 523{\cdot}1$).

The oxide of Er_α behaves differently from that of Er_β on a fractionated decomposition of the nitrates. Out of the total quantity of the earths from the Hitterö euxenite there passed into the Fractions I. to XLIII. approximately equal but very small quantities of Er_α, for $\lambda = 654{\cdot}7$ could be distinguished only very faintly in the spectra of all the fractions. Er_β, in accordance with the intensity of $\lambda = 523{\cdot}1$ was present in Fractions I. to VI. in relatively large quantities, but it is met with only in very small quantities in the last fractions of the Hitterö euxenite. This different occurrence of the two bands of so-called erbium in the spectra of these euxenite fractions seems to signify that they cannot belong to the same element. Further evidence in support of this view may be easily found on examining the observations tabulated above.

(To be continued).

YUCCA ANGUSTIFOLIA: A CHEMICAL STUDY.*

By HELEN C. De S. ABBOTT,

Fellow of the American Association for the Advancement of Science; Member of the Academy of Natural Sciences, Philadelphia; of the Berliner Chemische Gesellschaft, &c., &c.

(Concluded from p. 149).

Quantitative Estimation of Saponin.†

The two methods of Christophsohn and Otten for the quantitative estimation of saponin were adopted. The wood of the root was examined.

A.—Ten grms. of the original powder were boiled with distilled water. The saponin was precipitated by baryta-water. After weighing, it was ignited, and the baryta estimated as carbonate, calculated into oxide, and deducted from the weight of the saponin-baryta, the difference being the weight of saponin.

B.—The saponin-baryta was decomposed by acid, and the weight of the sapogenin was ascertained and calculated to saponin.

Several estimations were made on two specimens of the Yucca, collected at different times of the year.

Mean percentage, A .. .. 8·95 per cent.
„ „ B .. .. 10·40* „

The *aqueous extracts* contained gum, albuminous substances, carbhydrates, glucose, saponin, organic acids, calcium oxalate, and no tannin, mineral acids, nor alkaloids. Arabin was not separated from gum (1). Calcium oxalate was brought into aqueous solution possibly by means of the organic acids or saponin. Needle-shaped crystals were found in *extract* (3). They did not respond to tests for formates, acetates, malates, citrates, tartrates, phosphates, oxalates, glucosides, and alkaloids.

Aqueous extracts of 50° C. to 60° C. from the bark and wood of the root contained inulin.

Dilute Caustic Soda Extracts.

Extract (1), *the Bark of the Root.*

The residual powder insoluble in water was suspended whilst moist in a dilute soda solution (0·1 to 0·2 per cent). After twenty-four hours the mixture was filtered. One volume of the filtrate was acidified with acetic acid and mixed with three volumes of 90 per cent alcohol, and allowed to stand in the cool. The precipitate was collected, washed with 75 per cent alcohol, dried, and weighed, deducting ash. It consisted of mucilaginous substances and albumenoids.

	Per cent.
Weight of precipitate by 90 per cent alcohol yielded	0·85
„ „ ash yielded	0·25

Lassaigne's test showed the presence of albuminous substances.

The filtrate and wash alcohol from the 90 per cent alcohol precipitate was evaporated to dryness, and weighed, deducting the amount of soda acetate. It gave 0·24 per cent. The residue soluble in water was mixed with acetate of copper solution. A very small quantity of albuminous substances was precipitated by the reagent.

The albumenoids of the bark were estimated from the total nitrogen in one grm. of the original powder. It yielded 4·75 per cent of albumenoids.

The powder insoluble in dilute soda solution was washed with distilled water. The liquid was deeply

* Reprinted from the *Transactions of the American Philosophical Society.*

† *Loc. cit.*, page 68.

* Examination of the *Yucca angustifolia*, by H. C. De S. Abbott. "The Medical and Surgical Reporter," Sept. 12, 1885, p. 301.

Summary IV. *Aqueous Extracts.*

	Solids extracted.	Ash.	Gum.	Ash.	Glucose.	Saponin. A.	Saponin. B.
1. The bark of the root	4·00 p.c.	2·65 p.c.	2·00 p.c.	0·20 p.c.	traces		
2. „ wood „	12·10 „	1·74 „	1·70 „	0·34 „	4·47 p.c.	8·95 p.c.	10·40 p.c.
3. „ green leaf	4·35 „	0·40 „	0·77 „	0·12 „	traces		
4. „ yellow base of the leaf	11·35 „	3·10 „	3·85 „	0·67 „	„		

coloured. It was evaporated, and the amount of solids estimated. It gave 1·3 per cent.

Extract (2), *the Wood of the Root.*

The powder insoluble in water was treated in the same way as in *extract* (1). The filtered solution was mixed with 90 per cent alcohol in the manner described. The precipitate was estimated, deducting ash.

	Per cent.
Weight of precipitate by 90 per cent alcohol yielded	2·170
,, ,, ash yielded	0·256

The filtrate from the 90 per cent alcohol precipitate was treated with water, and the soluble matter precipitated by copper acetate. The precipitate was collected, dried, weighed, and ignited, the resulting oxide of copper being deducted. It yielded 0·104 per cent of albumenoids. A current of washed carbonic acid was passed through the *dilute soda extract* to determine the presence of globulin (vitellin, myosin), and with negative results. The albumenoids were determined from the total nitrogen in the powdered wood. It amounted to 4·75 per cent. The total albumenoids in the leaves gave 9·62 per cent.

Dilute Hydrochloric Acid Extracts.

Extract (1), *the Bark of the Root.*

The powder insoluble in dilute soda was washed with water and suspended in water containing 1 per cent of hydrochloric acid. The absence of the blue colour which the starch granules assume when treated with iodine solution was determined by examining the bark under the microscope; and consequently it was not looked for in the *extract*. A qualitative test showed the presence of calcium phosphate, and calcium oxalate. A measured quantity of the *filtrate* was neutralised with ammonia and mixed with three volumes of 90 per cent alcohol. The precipitate was collected on a weighed filter, washed with 60 per cent alcohol, dried, and weighed. It was incinerated, and the ash deducted from the precipitate.

The precipitate yielded	5·20 per cent
,, ,, ,, of ash	0·98 ,,
Organic substance	4·22 ,,

The filtrate from the 90 per cent alcohol precipitate was evaporated. The residue was composed of ammonium chloride, from the reagents employed, and an organic substance having an odour like gum benzoin. It was agitated with ether and on evaporating the solvent a white residue with an odour like benzoin was obtained. Sulphuric acid gave a red colour with it. The amount of this substance was calculated. It gave 0·45 per cent.

Extract (2), *the Wood of the Root.*

The insoluble powder from the dilute soda maceration was washed with distilled water, and suspended in water containing 1 per cent of hydrochloric acid. The same means were used as in *extract* (1) to determine the absence of starch in the wood of the root. Parabin was also absent. Calcium oxalate was detected by qualitative tests. A similar method, as employed for its estimation in extract (1), was used to determine it quantitatively.

The precipitate yielded	0·305 per cent.
,, ,, ,, of ash	0·155 ,,
Organic substance	0·150 ,,

Extract (3), *the Green Part of Leaf.*

The powder used in the dilute soda maceration was washed with distilled water and suspended in water containing 1 per cent of hydrochloric acid. Iron and calcium phosphate were detected in the extract. The leaves were examined under the microscope, and a blue colour was developed by an aqueous solution of iodine, indicative of starch granules. Starch was also present in the yellow base of the leaves.

In my paper on the "Chemical Study of *Yucca angustifolia*," read at Ann Arbor, Mich., I stated what methods I had employed to separate saponin, and the properties of the compound as observed in that plant. Since which time a further study of it has induced me to withhold the notes used at Ann Arbor, from this, and to offer them, with those collected later, in a separate and more complete publication (See Table below).

I am indebted to Dr. F. M. Endlich, for his courteous consideration and kindness in selecting and forwarding the fine specimens of *Yucca* which were used in these analyses, and which were grown in the neighbourhood of Lake Valley, New Mexico. Within a few weeks I have received, in addition, several hundred pounds of the plant from Dr. Endlich.

The investigations described in the preceding pages were conducted in the chemical laboratory of the Philadelphia College of Pharmacy, from February to August, 1885.

PERCENTAGE OF ASH IN BONES OF DIFFERENT AGES.

By WILLIAM P. MASON.

Referring to "Watts's Dictionary of Chemistry," under the subject "Bone," we find two tables of analyses of bones, one by Von Bibra and the other by Frémy. These two scientists do not arrive at the same conclusion. Von Bibra states that:—"The portion of inorganic matter in bone is smaller in youth than in age, although no regular gradation can be observed: while Frémy holds that "The bone of a fœtus was found to yield the same quantity of ash as that of a woman of ninety-seven years of age." Although the actual number of analyses made by these

Total Quantitative Results.

	(1). The bark of the root.	(2). The wood of the root.	(3). The green part of leaf.	(4). The yellow base of leaf.
1. Moisture	6·78 per cent	11·67 per cent.	8·11 per cent.	37·00 per cent.
2. Total ash	17·38 ,,	15·75 ,,	5·75 ,,	10·63 ,,
3. Petroleum spirit extract	1·24 ,,	0·55 ,,	2·20 ,,	1·10 ,,
4. Ethereal extract	3·16 ,,	1·70 ,,	1·25 ,,	1·70 ,,
5. Alcoholic ,, ...	9·25 ,,	14·30 ,,	3·80 ,,	4·30 ,,
6. Aqueous ,, ...	4·03 ,,	16·10 ,,	4·35 ,,	11·35 ,,
7. Dilute soda ,, ...	1·09 ,,	2·41 ,,		
8. Wash residue	1·30 ,,			
9. Dilute acid extract	5·65 ,,	0·30 ,,		
Total percentage	49·88 ,,	62·78 ,,	25·46 per cent.	66·08 per cent.
Total albumenoids estimated on powder.	4·75 ,,	4·74 ,,	9·62 ,,	
Quantitative saponin determination on powder by A and B.		A. 8·95 per cent. B. 10·40 ,,		

Number.	Sex.	Colour.	Nationality.	Occupation.	Died of.	Age, years.	Per cent of ash.	Remarks.
1.	Specimen lost.							
2.	Male.	White.	—	—	Phthisis.	65	67·05	
3.	,,	Negro.	—	—	,,	21	65·89	Had scrofula.
4.	,,	White.	Russian.	Sailor.	,,	23	67·28	,, syphilis.
5.	,,	,,	American.	Farmer.	—	33½	67·63	Amputation.
6.	Female.	,,	Irish.	Actress.	Peritonitis.	23	67 66	
7.	Male.	,,	—	—	Phthisis.	60	67·55	
8.	Female.	,,	Irish.	—	,,	24	68·29	
9.	Male.	,,	—	—	,,	57	67·73	
10.	,,	,,	—	—	,,	58	67 60	
11.	,,	,,	—	—	,,	57	68·82	
12.	Female.	Negro.	—	—	?	25	68·20	Died of some bowel disease.
13.	Male.	White.	Irish.	Labourer.	Killed.	21	67·73	
14.	,,	,,	English.	Brewer.	—	31	66·51	Amputation.
15.	,,	,,	Irish.	—	—	8	64·86	Amputation.
16.	Female.	,,	,,	Domestic.	Phthisis.	46	69·67	Married.
17.	,,	,,	French.	—	Peritonitis.	57	67·60	,,
18.	Male.	,,	American.	Farmer.	Old Age.	81	68·56	
19.	,,	,,	Irish.	—	Apoplexy.	60	69·33	Married.
20.	,,	,,	,,	Labourer.	Bronchitis.	74	68·72	
21.	Female.	,,	American.	—	Phthisis.	44	68·30	Married.
22.	,,	,,	Irish.	—	,,	60	67·93	Insane.
23.	Male.	,,	German.	—	?	40	69·28	
24.	,,	,,	,,	—	?	53	68·23	
25.	,,	,,	Irish.	—	Phthisis.	56	68·94	
26.	,,	,,	,,	—	Brights'.	41	68·15	
27.	,,	,,	,,	Labourer.	Dysentery.	48	69·73	
28.	Female.	,,	American.	—	Phthisis.	29	69·18	
29.	,,	,,	,,	—	,,	34	69·82	
30.	Male.	,,	Italian.	Labourer.	Tetanus.	29	68·47	Died from wounds.
31.	Female.	,,	American.	Domestic.	Typhus fever.	24	67·99	
32.	Male.	,,	—	—	Nephritis.	49	69·35	
33.	,,	,,	—	—	Alcoholism.	58	68·69	
34.	,,	,,	Irish.	—	—	11	65·87	Amputation.
35.	,,	,,	German.	—	Phthisis.	59	68·93	
36.	Female.	,,	Irish.	—	,,	29	69·03	
37.	Male.	,,	,,	—	Pneumonia.	55	69·72	
38.	,,	Negro.	—	—	Phthisis.	45	69 06	
39.	,,	White.	German.	Brewer.	?	40	69·31	
40.	,,	,,	English.	Tailor.	?	73	69·85	
41.	,,	,,	Irish.	Labourer.	Killed.	38	69·05	
42.	,,	,,	,,	None.	Phthisis.	25	69·36	Drunkard.
43.	,,	,,	American.	Ostler.	Alcoholism.	63	68·07	,,
44.	,,	,,	English.	Coachman.	,,	43	65·11	Had syphilis.
45.	,,	,,	—	Shoemaker.	,,	45	65·16	
46.	,,	,,	—	Lawyer.	Old age.	70	62·82	
47.	Female.	,,	—	Prostitute.	Phthisis.	26	65·23	
48.	,,	,,	—	Domestic.	,,	31	65·61	Bone very brittle.
49.	Male.	,,	German.	Shoemaker.	,,	38	63·98	
50.	,,	,,	Irish.	Labourer.	?	61	63·54	

investigators was large, yet simple inspection of their tables will show that very few were made of the *same bone* in each case, and it is evident that a comparison between a femur, on the one hand, and a tibia on the other, could not be trustworthy.

It occurred to me as worth while to supplement their list, and I here present what may be considered a report of progress, very much yet remaining to be done.

The *extreme* difficulty of getting supplied with material, the history of which is certain and satisfactory, renders the work exceedingly slow.

The bone for examination was, in every instance, cut from the dense portion of the middle of the shaft of the femur. No subject was taken who had suffered from rickets or other serious bone disease, and women of recent confinement were also excluded. All specimens were obtained either from living persons (amputations), or those recently dead. After crushing with a steel mortar, extracting with ether, and again crushing, the ash was determined by incineration in a platinum dish. The results are in the appended table.

I think enough has been done to show that the common belief in the increased brittleness of bone with advancing years being due to increased percentage of inorganic salts is without foundation. The table indicates that after manhood is reached no variation in quantity of ash takes place as the years roll on.

"The greater brittleness of the bones in age is attributed by Frémy to the increase in the proportion of the spongy tissue, the thickness of the hard and dense portion of the bones continually diminishing as age advances." This has not been my experience. Transverse sections of the entire bone were made in each case in order to test this point, by observing the relative size of dense and spongy portions, and I certainly saw nothing to warrant such a conclusion. At the same time, small columns $\frac{1}{8} \times \frac{1}{8} \times \frac{3}{4}$ inch were cut from the dense portion of the shaft, and were broken transversely on a testing machine, in order to determine the amount of brittleness.

The most brittle specimen I had (No. 48) showed a rather thicker dense portion than usual.

I find the brittleness to be in the *material* rather than in the bone as a structure.

I append a very imperfect table of the results obtained on the testing machine. Every bone, as I received it, could not be cut so as to give a column of the size re-

quired for breaking. It will be noticed that, in general, strength of bone diminishes as age advances.

Loss of material by the burning of the laboratory affected, in a measure, the completeness of the work.

Breaking Weight for Column of Bone $\frac{1}{8} \times \frac{1}{8} \times \frac{3}{4}$ inch, Broken Transversely.

Age.	Pounds.
25 years.	75
26 ,,	74
31 ,,	50
38 ,,	64
43 ,,	58
45 ,,	60
61 ,,	55
63 ,,	30
70 ,,	54

Rensselaer Polytechnic Institute,
Troy, N.Y., July 28, 1887.

NOTICES OF BOOKS.

Notes on the Literature of Explosives. By Ch. Munroe. 1887. No. XIII.

In an abstract of a valuable paper by Prof. F. v. Rzika, upon "The Mechanical Efficiency of Explosives," we read that, according to various authors, 1 kilo. of gunpowder developes when exploded a theoretical power varying from 67,410 k.m. (Bunsen and Schischkoff) to 161,500 k.m. (Berthelot); but these results are exceeded by those obtained by MM. Roux and Sarran, who found that different powders of given constitution gave results varying between 242,335 k.m. and 343,102 k.m. Guncotton gave 448,927 k.m., and dynamite containing 75 per cent of nitroglycerin gave 548,250 k.m.

Experience has shown that, in blasting rocks, two to three times as much powder as dynamite will be required to achieve the same result, the theoretical relation being 1 : 2·26, which is a very close approximation when we consider the constantly changing conditions of rock-blasting.

The theoretical efficiency of an explosive cannot, however, be realised in useful work, because of incomplete combustion, the compression and chemical changes in the surrounding material, the cracking and heating of rock not moved, and because of the escape of considerable quantities of the gases through the blast-hole and the fissures formed by the explosion. The problem can therefore only be solved by means of analogy, such as firing shot from ordnance, &c. The mean of a large number of experiments gives the useful work from 1 kilo. of powder, when fired in a gun, as 43,788 k.m.; and taking MM. Roux and Sarran's value of the theoretical power latent in the powder as 319,982 k.m., we find that, under the average conditions of modern gunnery, we can only get a return of 13·71 per cent of the possible power.

In *Engineering News* a new explosive is partially described: it is the invention of M. Gruson. Although tried by the German Government so long ago as 1882, its composition is still kept partially secret. One ingredient is strong nitric acid, and the other a brown crystalline substance, non-explosive by itself, but burning like sealing-wax, often transported in commerce, insoluble in water, poisonous if eaten, but unknown in this special character of forming an explosive when dissolved in nitric acid.

Another new explosive is called "Bellite." It is more powerful than any other at present used.

Another remarkable one, invented by a Russian engineer, and called "Silotvaar," is said to possess ten times the power of ordinary powder, while at the same time "its explosion produces neither fumes nor smoke, and is not attended with any detonation." We only want to hear that it gives no recoil, and we shall be inclined to believe that the so-called explosive does not explode at all.

Journal of the College of Science, Imperial University, Japan. Published by the University, Tokyo. 1887.

The third part of this interesting Journal, which has recently appeared, gives ample evidence of the activity of scientific workers in that strange land which is making such rapid advances in European civilisation.

Messrs. Mitsukuri and Tshikawa contribute an important paper "On the Formation of Germinal Layers in Chelonia." The results of their observations and investigations most completely bear out the views taken by Balfour and Hertwig, viz., that the development of Amphioxus and Amphibia, on the one hand, and Reptilia on the other, is as complete as could be desired, and the authors express the hope that their investigations may furnish an intermediate step in firmly establishing the views of these two observers in higher Vertebrates.

Another paper which attracts attention is one on "The Severe Japan Earthquake of 15th January, 1887." Since 1879 there have been seven destructive earthquakes in Japan, but the shock of last January was of most unusual violence. It originated near the coast at a point about 35 miles from Tokyo, and the seismic waves travelled nearly 200 miles along the Pacific seaboard; they shook in all about 32,000 square miles of land. From observations recorded it is found that the greatest horizontal movement was 21 m.m., and the time taken to complete one to and fro movement was 2·5 seconds. The principal motion continued for more than two minutes, during which time no less than sixty distinct shocks occurred. The most probable cause of the shock was faulting or dislocation of the earth's crust, this inference being supported by the fact that the parts of the country through which the western half of the line of shock travelled consists of rocks of different geological formations, interwoven in such a way that their junctions present lines of weakness favourable to earth-snaps.

The damage to dwelling-houses was very great and widespread, but owing to their light construction (they are principally built of wood and bamboo) very few were entirely overthrown. The real destroyer, which is so much feared in connection with earthquakes in Japan, is fire. The extensive and rapidly increasing use of kerosine lamps in Japan augments the danger very considerably. In the great earthquake of 1855 fire broke out in more than thirty places in Yedo, and a large part of the city was quickly in a blaze. Fortunately this last shock only caused a few fires, and these were promptly extinguished.

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*Handbook of Chemical Technology.** Edited by Dr. Bolley, and continued after his death by Dr. Birnbaum. First Volume, Third Group: *Chemical Technology of Fuel.* By Dr. Ferdinand Fischer. Braunschweig: Vieweg and Son.

This book, as it reaches us, is a "new thing under the sun." It begins on p. 161, in the middle of a sentence, without the luxuries of a preface, a table of contents, or even of a title-page beyond what we find printed upon the wrapper.

It opens with a fragment of the instructions for determining the heating power, apparently of coal. The author then proceeds to the examination of atmospheric air, giving elaborate instructions for the determination of moisture, of oxygen, carbonic acid, and carbon monoxide. Hydrogen sulphide, sulphurous acid, sulphuric and hydrochloric acid, and ammonia are much more briefly dispatched. Dust, or rather suspended matters, inorganic, organic, and organised, are also slightly noticed. It is

* Handbuch der Chemischen Technologie. Ersten Bandes, dritte Gruppe: Die Chemische Technologie der Brennstoffe.

maintained that the air of cesspools is especially rich in bacteria.

The next subject taken up is the examination of furnace and chimney gases, which is treated at great length and with the aid of a profusion of diagrams.

Next comes coal-gas, in which he determines specific gravity, carbon dioxide, ammonia, and sulphur.

In a following section the author returns to atmospheric air, giving additional means for the determination of oxygen, carbon dioxide, and monoxide. For the detection of small proportions of the latter it is proposed to shake up a sample of the suspected air with a solution of blood, previously mixed with ammonium sulphide, and in which the reduction-band has been first observed. Carbon monoxide-hæmoglobin is formed, and its characteristic band may be recognised spectroscopically. If a solution of blood, which, after treatment with ammonium sulphide and potassa lye, shows merely the characteristic absorption of hæmochromogen, is shaken up with air containing mere traces of carbon monoxide, there appears after standing a less intense absorption of hæmochromogen, and more or less strong bands of carbon monoxide-hæmoglobine. In this manner 0·033 per cent of this dangerous gas may be detected.

The remainder of the book is chiefly devoted to photometry.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., Nos. 10 and 11, September 5 and 12, 1887.

These numbers contains no chemical matter.

Bulletin de la Société Chimique de Paris.
Vol. xlvii., No. 10, May 20, 1887.

Causes which determine the Phosphorescence of Calcium Sulphide.—A. Verneuil.—Already noticed.

On Alums.—E. Maumené.—Already noticed.

A Reaction serving for the Colorimetric Determination of Phosphorus in Cast-Iron, Steel, &c.—F. Osmond.—On dissolving the phospho-arsenio-silico-molybdic acids or their alkaline salts in a hydrochloric solution of stannous chloride, there is produced a blue colouration, proportional in its intensity to the quantity of the molybdic derivative produced. Under the same conditions, the salt of tin being always in large excess, ammonium molybdate gives a colouration which passes through blue (if the molybdate is in sufficient quantity), but turns quickly to a reddish yellow. The molybdic acid is finally converted into MoO_2. Upon the production of the blue colour just mentioned the author founds his colorimetric process for the determination of phosphorus in iron. He forms his stannous solution by dissolving 12 grms. of tin crystals in 80 c.c. of pure hydrochloric acid and making up to 1 litre with distilled water. The precipitate of ammonium phospho-molybdate obtained in the ordinary manner is filtered through asbestos (*not* paper), and after washing it is dissolved on the filter with a sufficient quantity of the stannous liquid. The filtered solution is then made up with the same liquid to 100 c.c. per grm. of the iron taken. It is then merely necessary to ascertain its colouring power.

Artificial Production of Magnetite.—Alex. Gorgen.—Already noticed.

A New Reagent for the Salts of Copper.—M. Aliamet.—The author dissolves neutral sodium sulphite, so as to have a solution saturated in the cold. He then adds pyrogallic acid, which dissolves very easily. This reagent is colourless, but with solutions of a copper salt of medium strength it gives an intense blood-red colour.

On the Hydrates of Sodium Arseniate.—H. Lescœur.—Already noticed.

A Combination of Hæmatine with Nitrogen Dioxide.—G. Linossier.—Already noticed.

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THE CHEMICAL NEWS.

Vol. LVI. No. 1455.

THE RELATION OF SCIENCE TO THE STATE.

IV.

One evidence of the unsatisfactory state of Science in Britain is so simple and so convincing that it may save us the trouble of invoking any of the numerous and eminent authorities whose conclusions here coincide with our own, such as Professors Huxley, Frankland, Tait, Cook, Dr. L. Wiese, Sedley Taylor, and others. It is this:—At the end of scientific treatises of a monographic character we generally find a very useful appendix in the shape of the bibliography of the subject,—a list of the works, memoirs, papers, &c., in which it has been previously discussed. Now in such bibliographies the names of British investigators figure but to a very small extent. As an instance we may take a work on the animal alkaloids,—the ptomaines and leucomaines,—and, looking over the index, note how small a part has been played by British men of Science.

But we have now to search for the causes of our national inferiority. It cannot be explained by any inherent shortcoming of the British and Irish mind. The country which has produced Newton, Davy, Dalton, Young, Faraday, Darwin, not to speak of any one still living, may safely measure itself with any of its rivals. Prof. Max Müller declared, not very long time ago, that he intellects of British youth were "of the same calibre" as those of the Germans. If we have failed in doing what our interests and our honour demand, it is not from racial inferiority, not in virtue of any natural defects, but by reason of blunders which may yet be remedied if we can only be brought to see them in their true light.

The first great obstacle has been that spirit which finds vent in the miserable cuckoo-cry "*cui bono?*" This is not because we are more practical or more utilitarian than our neighbours. France, Germany, Belgium are all as greedy as we can be for the crumbs that fall from the table of Science; but they have confined themselves less closely to the demand for *immediate* results. They have had the insight or the faith to see the connection between the frog's leg, quivering on Galvani's work-table, and the electric light, the telegraph, and the telephone, and to judge that other abstract researches may be similarly fruitful. We have been less ready so to do, and here, if anywhere, lies our national inferiority. We alternate between vain-glorious self-confidence and fits of panic, in which we generally do the wrong thing. We seek to win the race by a succession of spurts, whilst our rivals press on "unhasting, unresting," taking their measures deliberately, and having an eye to the future as well as to the present.

Just now we are in one of our panic fits as regards scientific and technical training, and shall doubtless commit some piece of expensive folly.

Unfortunately the old utilitarian "*cui bono*" men have lately been reinforced by the ethicists who sneer, *e.g.*, at researches on the rare earths, asking "Could we not be as good and as happy if these rare earths had never existed?" But what we should be in the absence of what exists in creation is an utterly idle question, since possibly we ourselves should not be at all. To us the sense for truth is a craving which is its own justification.

However this may be, it must be admitted that the *cui bono* spirit is really the main origin of the unsatisfactory position of Science in our midst, other causes being but secondary. To these, however, we must proceed.

We shall do well to bear in mind—what some persons are inclined to forget—that scientific men, and those who might under favourable circumstances become such, have very much the same wants and the same feelings as other men. Hence if they find that a life devoted to original research—which is in itself an expensive pursuit—leads to semi-starvation, not compensated by public recognition or honours, they can scarcely be blamed if they decline to sacrifice themselves for the good of posterity, to whom, perhaps, their very names will never be known.

Hence in Britain scientific research has been confined mainly to those who combine with the necessary intellectual and moral gifts a position independent in a pecuniary point of view, and who are, further, careless of amassing wealth and indifferent to the honours which may be gathered in other pursuits. As Mr. Sorby has most convincingly shown, research, to be fully successful, needs unlimited leisure,—the opportunity to take up and study phenomena when they present themselves, and to follow out suggestions as they occur to the mind.

We must admit that a modern author pronounces "work supported by private means amateur work or duplicate work." This we hold to be a capital mistake, which is at once scattered to the winds if we mention the names of Cavendish, Lyell, and Darwin.

Meantime that Science, in the true sense of the word, "does not pay" is fully recognised by the world. If a young man shows an inclination for research he is duly cautioned not to be guilty of such folly. His friends advise him rather to turn his attention to the law, to politics, to divinity, or to speculation, the investigation of Nature being at best reserved as a pastime for leisure hours. Or he may be recommended to sink into the routine application of well-known truths, as an engineer or a physician. We are fully aware that engineers, physicians, lawyers, and clergymen have often made valuable contributions to the various sciences. But how much more could they have done had their whole time been at their disposal! We are told, with the fullest truth, that there is no commercial career open to a biologist. Mr. Proctor even tells us, in "Wages and Wants of Science Workers," that "the existence of a commercial career for the chemist has the effect of starving all the other sciences for the benefit of one of them." We are quite unable to accept this view. We do not see that the demand for the services of chemists can in the least interfere with the position of astronomers or biologists.

There is, of course, an opening for a small number of astronomers in observations, and for a few biologists in museums and botanical gardens; but, as far at least as astronomers are concerned, Mr. Proctor tells us that a careful avoidance of originality is the quality most valued in subordinates. Such establishments must therefore be ill adapted for a man capable of extending the boundaries of knowledge.

We further find that if any Government Department stands in need of advice or information which only a chemist, a physicist, or a biologist can furnish, it generally expects such work to be undertaken gratuitously. If the *savant* consulted asks beforehand what remuneration he may expect the matter is dropped, and if he acts as if he would do in case of a firm or company he is told that there are no funds applicable to such a purpose. But, on the contrary, if any *legal* service is required, though the person employed may be the most briefless of barristers, he is sure of being paid handsomely; so different is the treatment accorded respectively to Law and to Science.

Chemical and Thermic Study of the Phenolsulphuric Acids.—J. Allain le Canu.—The author concludes that the introduction of an electro-negative element in place of hydrogen effects scarcely any change in the thermic value of the first basicity, whilst it increases in a striking and progressive manner the value of the second.—*Bull. de la Soc. Chim. de Paris.*

THE THERMAL RESULTS OF NEUTRALISATION, AND THEIR BEARING ON THE NATURE OF SOLUTION.*

By W. W. J. NICOL, M.A., D.Sc., F.R.S.E. F.I.C.,
Lecturer on Chemistry, Mason College, Birmingham.

WHEN a solution of a base in water (one equivalent in 200 or more molecules of water) is neutralised by the requisite quantity of a solution of an acid of the same strength, the thermal change observed is the algebraic sum of the plus and minus quantities contained in the following thermal statement,—

$$-MOH,Aq - M,OH - HR,Aq - H,R + M,R + MR,Aq + H,OH + H_2O,Aq,$$

where M and R are equivalents of metal and salt-radical respectively. With the single exception of $H_2O,Aq = O$ we have not the slightest knowledge of the value of any of the terms of the above statement; for it must be constantly remembered, in considering these questions, that MOH,Aq, HR,Aq, and MR,Aq are not the heats of solution of solid or even liquid base acid or salt, but are the thermal results of the bringing in contact of single molecules of these substances and a very large excess of water. Similarly M,OH, H,R, M,R, or H,OH is the thermal resulting from the formation of single independent molecules of these substances, not of solid or liquid aggregates of their molecules.

It has been found by experiment that the algebraic sum of the above thermal changes is a constant whatever may be the value of M (provided always that MOH is soluble in water), and that various values of R give definite constants for all values of M. That is—

$$-M,OH - MOH,Aq - H,R - HR,Aq + M,R + MR,Aq + H,OH + H_2O,Aq = = -M',OH - M'OH,Aq - H,R - HR,Aq + M',R + M'R,Aq + H,OH + H_2O,Aq.$$

Or simplified—

$$-M,OH - MOH,Aq + M,R + MR,Aq = = -M',OH - M'OH,Aq + M',R + M'R,Aq.$$

Which may be written—

$$M,R,Aq - M,OH,Aq = = M',R,Aq - M',OH,Aq.$$

Now, setting R' = OH, we have—

$$M,R,Aq - M,R',Aq = M',R,Aq - M',R',Aq,$$

and this equation is found to hold good for all values of M and M', R and R'.

Such an equation is valid under one or other of three conditions:—

1st. All the four terms are equal.

2nd. The first and third are equal, the second and fourth are equal.

3rd. None of the four terms are equal: there is thus equality only in the differences between each pair.

This last is the condition obtaining here, for if we set M = K, M' = Na, R = Cl, R' = Br, then—

$$K,Cl,Aq - K,Br,Aq = Na,Cl,Aq - Na,Br,Aq.$$
$$101{\cdot}170 - 90{\cdot}230 = 96\,510 - 85{\cdot}580.$$
i.e., 10·940 cals. = 10·930 cals.

Now each of the terms of the above equation consists of two parts. Thus M,R,Aq can be divided into M,R and MR,Aq, and so with the others. We are thus confronted with the question, Does the same relation or equality exist between the equations obtained by dissecting the original equation, or does it not? Do—

$$M,R - M,R' = M',R - M',R', \text{ and}$$
$$MR,Aq - MR',Aq = M'R,Aq - M'R',Aq,$$

or do they not?

If they do not,—if MR,Aq − MR',Aq do not equal M'R,Aq − M'R',Aq,—then it follows that there is no connection between the heat of solution (in the restricted sense defined above) and the chemical composition of the salt. But the heat of solution of single salt molecules must depend on their chemical composition, whether the act of solution be chemical or physical. It seems to me impossible that it could be otherwise. We must not be led away by the absence of such relations in the case of the heat of solution of solid salts, for in these cases the question is complicated by physical conditions, such as exigencies of crystalline form, rapidity of cooling, &c., and it is only in certain instances that we can trace out the connection.

A great deal of light may, however, be thrown on this point by the study of the vapour pressure of water from dilute salt solutions. The restraining effect of salt on the vapour pressure of water is in dilute solutions a direct measure of the attraction exerted by the salt molecule on the water. This is best expressed by the value of—

$$\frac{p - p'}{n\,p} \times 1000,$$

where p = pressure of pure water, p' = pressure of vapour from the salt solution at the same temperature, and n = number of salt molecules present per 100 H_2O. At present the data are very insufficient in number for the proper examination of this point; but if we examine the figures given by me for sodium chloride and nitrate, potassium chloride and nitrate, we shall find that they are satisfactorily confirmed by Emden (*Wied. Annal.*).

	NaCl,Aq.	−	$NaNO_3$,Aq.	=	KCl,Aq.	−	KNO_3,Aq.
Nicol ..	192	−	189	=	172	−	171
Emden..	208	−	208	=	178	−	181
Mean	200	−	199	=	175	−	176

In this case it would seem that the metal played the important part in determining the attraction, but I wish to insist more on the knowledge to be gained from such experiments than on the strict accuracy of the figures given above: the subject of vapour pressures is one that is beset with innumerable experimental difficulties, and has by no means received the attention it deserves.

Again, this equality of relationship between the heats of solution of different salts is highly probable, for the attraction, adhesion, chemical or physical, whatever it may be that exists—as it undoubtedly does—between the salt and the water, must be connected directly with the composition of the salt.

Turning now to the other equation,—

$$M,R - M,R' = M',R - M',R'.$$

This also must hold if the equation of the heat of solution holds good. There will thus be a constant relationship observable between the heats of formation of single molecules of the salts in question. We have unfortunately no means of ascertaining whether this is the case or not. Nor is there any indirect evidence which can throw any light on this: still a little reflection will show that it is in accordance with the probabilities of the case.

When a metal, M, is brought in contact with a salt radical, R, they unite to form a salt, MR, and the thermal change M,R is a function not only of M, but also of R. This two-sidedness of such reactions is too apt to be lost sight of in considering such combinations. The kinetic energy resulting from their union is dependent for its amount on the nature of both constituents of the salt. Now either the whole of the potential energy of M and of R is converted into kinetic on their union, or only a portion of it, and the same is true of M,R'. If the whole of the potential energy is converted, then any difference in the total kinetic energy must be due solely to the difference in the potential energy of R and R'. Similarly with M',R and M',R' it is evident that the difference can be due only to R and R', that is—

$$M,R - M,R' = M'R - M',R'.$$

* Read before the Chemical Section of the British Association, Manchester Meeting.

If, on the other hand, only a portion of the potential energy of M and R be converted, two conditions are possible :—

1st. One or other of the constituents has the whole converted, the other not.

2nd. Neither constituent has the whole converted.

In the first case, if M has the whole converted, then the difference must be due to the difference between R and R′; or, if R, then to the difference between M and M′ and the equation still holds good.

In the second case, where only a portion of the potential energy possessed by constituents is converted into kinetic energy, it seems to me that the only possible state of things is as follows :—

The amount of energy converted in the case of M must be dependent on the nature of R and of R′ respectively, and in the case of R and R′ on the nature of M. This must also be the case with M′, and consequently, though the total kinetic energy in the various cases may be exceedingly different in amount, there is still an equality in the differences as in the other cases. Were it otherwise, then the amount of potential converted into kinetic energy would not be conditioned by the chemical nature of the various constituents, but be due to some other property as to the nature of which it is useless to speculate.

The whole of the foregoing may be summarised thus if the thermal change is in any way dependent on the chemical nature of the constituents; then M,R − M,R′ must equal M′,R − M′,R′.

That there is no relationship of this kind exhibited by the heat of formation of the solid salt is only what is to be expected, as I have already pointed out in the case of heat of solution. It is the simplicity of constitution in solution that reveals these relations,—a simplicity compared by Thomsen to that of the gaseous state.

The enormous dilution necessary before the exact equality is observable, in many cases, is also strongly in favour of this view, for all our experimental evidence points to this, that the more dilute the solution the more perfect the equality. Now such a variation of the thermal results with the amount of water present, if the whole is to be ascribed to chemical causes, would point to a chemical action varying continuously with the amount of water. Such an action cannot be a dissociative one, for the vapour pressures show that the whole of the water is affected by the salt, and in the majority of cases there is no room for believing in the dissociation of the salt itself. We are therefore driven to the conclusion that the action, if chemical, is due to the chemical combination of the salt with the water, and consequently to admitting the existence of chemical compounds absolutely indefinite in composition, this being conditioned solely by the amount of water present.

For the discussion of these questions from a totally different standpoint, reference may be made to a paper by Pickering (*Chem. Soc. Journ.*, 1887), where diametrically opposite conclusions are arrived at.

ON THE

ESTIMATION OF POTASH IN COMMERCIAL FERTILISERS.

By DAVID LINDO.

The following is an outline of a method proposed by Gladding at the Second Annual Meeting of Official Agricultural Chemists at Washington, September, 1885, for separating and estimating potash in superphosphates.

Boil 10 grms. of the fertiliser with 300 c.c. water for ten minutes; precipitate the solution when cold with ammonia in slight excess; make up the volume to 500 c.c., mix thoroughly, and filter through a dry filter.

Take 50 c.c. of the filtrate, corresponding to 1 grm. of the manure; evaporate nearly to dryness, add 1 c.c. dilute H_2SO_4 (1 to 1), evaporate to dryness, and ignite the residue until perfectly white. Dissolve the residue in hot water plus a few drops HCl, and 5 c.c. of a solution of pure NaCl (containing 20 grms. to the litre) and an excess of platinum solution, the whole to be evaporated as usual. The precipitate is to be washed thoroughly, first with alcohol, then with a half saturated solution of NH_4Cl, (which has been saturated with K_2PtCl_6), finally again with alcohol; dried and weighed as usual.*

The presence of the residue and precipitate in the measuring flask will, of course, give rise to a slight error in excess, which may be balanced or more than equalised by the precipitate carrying down a little of the potash salt. Experiments were tried—

1st. To ascertain if the method will give concordant results.

2nd. To ascertain if the results obtained by it are fairly accurate.

Experiments to Ascertain if the Method will give Concordant Results.

These were made with a so-called black guano, which was sent to me as a well mixed sample. It was in the state of a tolerably fine black powder, free from lumps.

I transferred it at once to an accurately ground reagent bottle, in which it was kept during the estimation of the following constituents, and during the potash estimates which were made after.

Each time, before taking out a portion for analysis, the bottle was well shaken.

Moisture expelled at 100°	14·58	per cent.
Ammonia (by distillation)	5·55	,,
Phosphoric acid, P_2O_5, total	11·83	,,
Phosphoric acid, P_2O_5, soluble in cold water	8·24	,,
Lime	16·08	,,
Magnesia	0·42	,,
Sulphuric acid, SO_3	28·36	,,
Chlorine	4·01	,,
Silica	0·50	,,
Ferric oxide	0·21	,,

Alumina was absent, and only a trace of soda present, a little animal matter was also present, and a rather considerable quantity of carbon.

Before giving the results of the potash estimates, I may state.

1st. That 50 c.c. of 6·34 per cent ammonia were added to each solution from 10 grms. of manure. This is more than a slight excess, but it was found, when slight excess —judging by the action on pink litmus-paper—was used, phosphoric acid and lime were sometimes *both* present in the filtrate, in which ammonia produced a further precipitate. Phosphoric acid will, as a rule, be present whether slight or large excess of ammonia is employed, if the fluid is filtered from the residue, soon after precipitating with ammonia. Its presence does no harm, at least in the absence of an appreciable quantity of lime.†

2nd. The 50 c.c. of filtrate taken for each estimate were evaporated, and the residue was ignited in a platinum dish.‡ The dissolved residue was transferred to a porcelain basin, and the NaCl and platinum solutions added.

3rd. The evaporation was always carried to dryness, as I believe this to be the safest plan.

4th. The K_2PtCl_6 in these experiments was always obtained in minute crystals, rendering crushing unnecessary, but the mass was worked with a trimmed feather with a little alcohol in the dish three or four times before transferring to the Gooch crucible, in which the washing was completed.

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* See Chemical News, vol. liii., p. 202, for further details.

† Less ammonia, however, than I have used in these experiments, would ensure complete precipitation of the lime, and, in practice, less should be used, unless alumina is known to be absent, as it was in all these experiments.

‡ When chlorides and nitrates are both present the evaporation with sulphuric acid must not be carried on in a platinum dish.

5th. The K_2PtCl_6 was dried at 130° C., and the factor 0·3056 used to convert into KCl. Repeated experiments have shown that when the salt is dried to constant weight at this temperature it always contained 30·56 per cent KCl.

6th. The platinum solution contained 1 grm. of metal in 20 c.c., and 8 c.c. were used in each estimate.

Five boils were made, using 10 grms. of manure for each, and two or three estimates were made from each filtrate; the results are given below.

TABLE I.

No.	Weights of precipitates in grms.	= KCl.	Per cent in manure.	Average.
		Solution A.		
1.	0·2371	0·072457	7·25	7·24
2.	0·2367	0·072330	7·23	
		Solution B.		
1.	0·2374	0·072549	7·25	7·25
2.	0·2375	0·072580	7·26	
3.	0·2371	0·072457	7·25	
		Solution C.		
1.	0·2305	0·07044	7·04	7·05
2.	0·2309	0·07056	7·06	
		Solution D.		
1.	0·2329	0·07117	7·12	7·12
2.	0·2329	0·07117	7·12	
		Solution E.		
1.	0·2326	0·07108	7·11	7·11
2.	0·2331	0·07123	7·12	
3.	0·2324	0·07102	7·10	

From these results we may infer that when several estimates are made from the same filtrate, using equal volumes, the results will be concordant.

That the various solutions have yielded a variable proportion of potash may be due to one or more of the following causes:—

1st. Imperfect mixing, the potash salt not being evenly diffused through the manure.

2nd. The few minutes boiling not having sufficed, in some instances at least, to extract all the soluble potash salts.

3rd. To the precipitates caused by ammonia carrying down a *variable* quantity of potash salt.

The balance of the manure was passed twice through an 18 mesh sieve, and very carefully mixed after each sifting. It absorbed sufficient moisture from the atmosphere under this free exposure to lower the tenor of all other constituents sensibly; therefore, the potash would come out lower without a correction, which, however, the experiments being merely to test concordance of results, it was quite unnecessary to make.

Six solutions were prepared, using 10 grms. for each, and one estimate made from each filtrate. The results are given in Table II.

TABLE II.

Weights of precipitates in grms.	= KCl.	Per cent in manure.
	Solution A.	
50 c.c. gave 0·2279	0·069646	6·96
	Solution B.	
50 c.c. gave 0·2299	0·070257	7·03
	Solution C.	
50 c.c. gave 0·2289	0·069951	7·00
	Solution D.	
50 c.c. gave 0·2291	0·070012	7·00
	Solution E.	
50 c.c. gave 0·2280	0·069676	6·97
	Solution F.	
50 c.c. gave 0·2286	0·069860	6·99

In preparing A and B the manure was boiled with the water fifteen minutes C was not boiled but digested at ordinary temperature (30° C) for about three hours, with frequent stirring. D, the manure, was stirred well with the 300 c.c. water, and the ammonia added at once.* E and F boiled in each case for two hours, renewing the water occasionally.

That the results are not quite as regular as those obtained when two or three estimates were made from the same filtrate (Table I.) may be due to the precipitates caused by ammonia carrying down a variable quantity of potash salts. We may conclude, however, that with a well mixed sample the method will give results at least fairly concordant.

Experiments to Ascertain if the Results obtained by the Method are Fairly Accurate.

Two artificial manures were prepared, one black and the other white.

Black Manure.—Bone-ash 100 grms.; animal charcoal (giving 15·04 per cent ash) 40 grms.; washed and dried; added 45 c.c. commercial pure sulphuric acid and 45 c.c. water in small quantities at a time alternately. After mixing, dried on water-bath, and ground fine. Added 40 grms. ammonic sulphate and 10 grms. magnesic sulphate (crystals), dried again, passed twice through 18 mesh sieve, mixed well, and left the mass lightly covered, stirring occasionally, until sufficient moisture had been absorbed, to admit of accurate weighing.

The phosphoric acid, lime, and ammonia were estimated.

Phosphoric acid, P_2O_5, total	14·20
,, soluble P_2O_5, 13·36 p.c.	
Lime	19·28
Ammonia by distillation	3·53

A preliminary experiment having shown it would be difficult to burn the residue white, in trying blank experiments with this manure, in consequence of alkaline salts being practically absent, 8 per cent of pure NaCl was added.

White Manure.—30 grms. microcosmic salt, 5 grms. magnesic sulphate (crystals) and 22 c.c. pure (re-distilled) sulphuric acid, mixed in a mortar. Added gradually 30 grms. pure calcic carbonate (precipitated by ammonic carbonate), dried, ground, sifted, and treated as above, to ensure accurate weighing.

The phosphoric acid was estimated, and from the result the ammonia and soda have been calculated.

Phosphoric acid, P_2O_5, total	12 14
,, soluble P_2O_5, 12·05 p.c.	
Sodic hydrate (calculated)	6·84
Ammonia (,,)	2·90

Three blank experiments were made with each manure.

Method.—2 grms. manure boiled a few minutes with 50 c.c. water, when cold added 10 c.c. 6·34 per cent ammonia; made up to 100 c.c., filtered off 50 c.c., and proceeded exactly as if potash were present.

Black Manure.

	Weight of precipitates in grms.
Blank 1	0·0066
,, 2	0·0065
,, 3	0·0067
Average	0·0066

White Manure.

	Weight of precipitates in grms.
Blank 1	0·0010
,, 2	0·0010
,, 3	0·0005
Average	0·0008

* In practice I should always boil for a few minutes It can do no harm, and it is just possible that with some samples cold water might not extract all the soluble potash salts.

The KCl used in the experiments that follow was prepared from purified potassic chlorate. I employed a 2 per cent solution, in preparing which the salt and water were both accurately weighed. Two of these solutions were made during the course of this enquiry; the results of their analysis by silver are given below.

No.	KCl taken.	Weight of precipitate. =	KCl found.
1.	0·205296	0·3946	0·20527
2.	0·198296	0·3812	0·19830

In practice not less than 10 grms. of a fertiliser—as recommended by Gladding—should be treated for a potash estimate, to ensure a fair average, but in these experiments much less could be used, the question of perfect mixing being excluded by adding a weighed quantity of KCl solution to the quantity of manure taken in each experiment.

Method.—The solution of KCl was roughly measured, transferred to a tared porcelain crucible, then accurately weighed, with the cover of the crucible on. Added 2 grms. of manure, and evaporated the whole to moderate dryness on a water-bath. The mass was then transferred to a beaker, boiled a few minutes with 50 c.c. water, 10 c.c. 6·34 per cent ammonia added, made up to 100 c.c., filtered off 50 c.c., and proceeded as usual.

In experiments 1, 2, and 3 with both manures 5 c.c. NaCl and 8 c.c. platinum solutions were used. In experiment 4 with both manures 8 c.c. NaCl and 16 c.c. platinum solutions were employed. The results are given in Table III.

Table III.

Black Manure.

Experiment.	KCl taken.	Weight of precipitates after deducting 0·0066. =	KCl found.
No. 1.	0·020214	0·0652	0·01992
,, 2.	0·034672	0·1118	0·03416
,, 3.	0·074844	0·2409	0·07362
,, 4.	0·140386	0·4510	0·13782

White Manure.

Experiment.	KCl taken.	Weight of precipitates after deducting 0·0008. =	KCl found.
No. 1.	0·022721	0·0734	0·02244
,, 2.	0·043158	0·1401	0·04281
,, 3.	0·072614	0·2348	0·07175
,, 4.	0·135326	0·4403	0·13455

The black manure, from its containing bone char, and giving a very voluminous precipitate with ammonia, is perhaps as unfavourable a sample as could have been selected to test the method with, while the white manure is probably just the reverse.

There can be little doubt the method will always give results somewhat below the truth, though, for the purpose intended, it may be considered sufficiently accurate.

The error with manures containing less than 8 per cent potash is not likely, in careful hands, to be much over 0·1 per cent, and will often be less. To ascertain if it occurs in the first stage of the process, which terminates in a filtrate, 50 c.c. of which, it is assumed, contains all the soluble potash salts in 1 grm. of manure; or in the second stage, in which the potash is separated from this filtrate, or partly in both, the following experiments were made.

In each experiment 2 grms. of manure were treated exactly as as in the blank experiments. When the 50 c.c. of filtrate had been transferred to the platinum dish, a weighed quantity of KCl solution was added, and the analysis proceeded with as usual. The results are given in Table IV.

It is pretty evident the result of experiment No. 3, with the black manure, is accidental, and that the loss which occurs takes place during the first stage of the process. I may conclude by observing that the difficulty in arriving in perfectly concordant and accurate results in estimating the various constituents in these manures is often considerable, owing to their hygroscopic instability, and the great trouble which getting a perfectly uniform mixture entails. But quite apart from this, the accurate separation of a small quantity of potash from such a mixture is a problem presenting difficulties which it is not too much to say our present analytical methods are insufficient entirely to overcome. The method proposed by Mr. Gladding is simple and expeditious, in these respects much superior to the standard method, which, if we are to judge by the published figures, does not often give as accurate results, even in the hands of experienced analysts, as the former method, to judge by the results here recorded, is certainly capable of affording.

Falmouth, Jamaica, B.W.I.,
August 15, 1887.

Table IV.

Black Manure.

Experiment.	KCl taken.	Weight of precipitates after deducting 0·0066. =	KCl found.
No. 1.	0·052146	0·1714	0·05238
,, 2.	0·065898	0·2156	0·06589
,, 3.	0·042872	0·1379	0·04214

White Manure.

Experiment.	KCl taken.	Weight of precipitates after deducting 0·0008. =	KCl found.
No. 1.	0·055726	0·1826	0·05580
,, 2.	0·066606	0·2180	0·06662
,, 3.	0·046552	0·1526	0·04663

ON THE

COMPONENTS OF THE RARE EARTHS GIVING ABSORPTION-SPECTRA.

By GERHARD KRÜSS and L. F. NILSON.

(Continued from p. 156).

3. *The Components of Thulium.*

In 1879 Cleve gave the name of thulia to the stronges base of all the erbia earths which give absorption-spectra In consequence of its basicity this oxide, even after several hundred careful decompositions of the mixed nitrates, remains in solution as a nitrate and becomes concentrated along with ytterbia in the mother-liquors. It has not been hitherto found practicable to obtain thulium free from ytterbium. Thalén, however, succeeded in establishing the spark-spectrum of thulium, having eliminated the ytterbium lines. Thulium oxide, if ignited in a flame, gives without volatilisation a discontinuous spectrum with two bands at $\lambda=684{\cdot}0$ and $\lambda=476{\cdot}0$. Lastly, the thulium salts, according to Thalén, give in transmitted light two absorption-bands at $\lambda=684{\cdot}0$ and $\lambda=465{\cdot}0$. The former was found more intense than the line $\lambda=465{\cdot}0$. The authors give the intensities of the two thulium lines according to their observations.

In the cases 1, 2, 3, 6, 7, and 8 of this table $\lambda=684{\cdot}0$ was always rather more strongly visible than $\lambda=465{\cdot}0$, and where the former line was fainter the latter was scarcely perceptible, or not at all. The observation of these spectra does not suggest any doubts as to the elementary character of thulium. Such doubts, however, are raised on comparing the results of an examination of the Arendal euxenite with those obtained from the mother-liquors of the ytterbia earths.

Fractions VIII. to XIV. of the euxenite material do not show $\lambda=465{\cdot}0$ at all, whilst at the same time $\lambda=684$ appeared rather strong or strong. The latter line appeared equally strong in the mother-liquors series 41 to 46, and yet $\lambda=465{\cdot}0$ was observed here rather strong.

In the spectrum of the earthly nitrates from—	There were observed the relative intensities of the thulium lines for— $\lambda=684{\cdot}0$.	$\lambda=465{\cdot}0$.
1. Thorite of Brevig	Extremely faint.	—
2. Euxenite from Hitterö, Fractions I. to IX.	Faint.	—
3. Euxenite from Fract. III., IV., and V.	Faint to rather strong.	—
4. Euxenite from " VIII.	Rather strong.	—
5. Arendal. " IX. to XIV.	Strong.	—
6. Mother-liquors Series 41 to 46	Strong.	Rather strong.
7. from preparation of " 47 to 53	Strong.	Faint.
8. Ytterbia-Earths. " 54 to 60	Rather faint.	Extremely faint.
9. Fergusonite from Arendal, Fractions VIII. and IX.	Rather strong.	—!
10. Thorite from Arendal, Yttria Earths	Rather strong.	—!

The relative proportion of the absorptions in the two thulium bands is therefore, in both these cases, not equal, as would be the case if thulium were a unitary body, a chemical element. That it consists of at least two elements appears further from a comparison of the spectra of the mother-liquors 54 to 60 with those of the fractions VIII. and IX. of the Arendal fergusonite and the yttria fraction from the thorite of Arendal. In the mother-liquors $\lambda = 465{\cdot}0$ can be plainly recognised, though $\lambda=684{\cdot}0$ appears rather faint. The stronger must the latter line be visible in the spectra of the fergusonite or thorite material from Arendal, as in them $\lambda=684{\cdot}0$ comes out not rather faint, but rather strong. The substance whose nitrate has the line $\lambda=465{\cdot}0$ in its absorption-spectrum appears not to occur at all in fergusonite and in the thorite of Arendal.

The authors propo e the name Tmα for the element whose nitric solution gives in the spectrum the band $\lambda=684{\cdot}0$ and Tmβ for that which produces $\lambda=465{\cdot}0$ under the same circumstances.

4. *On the Components of Didymium.*

Two years ago Auer von Welsbach resolved didymium by fractionated crystallisation of the double ammonium nitrate in a strongly nitric solution into two constituents which he named praseodymium and neodymium. The absorption-spectra of the compounds of these elements are portions of the absorption spectrum hitherto regarded as characteristic of didymium. If these elements are mixed in certain proportions both the colour of the solution and the original spectrum of didymium re-appear unchanged.

Hereby, as well as by the researches of Cleve, it is proved beyond doubt that didymium is a compound body. Unfortunately it was not practicable for the authors to ascertain any details on the constituents of didymium from Auer's memoir, the results of which depend upon spectroscopic examinations of the different fractions.

Certainly, beautifully executed drawings of the several spectra are appended to the memoir, but as the position of the single lines is only given with reference to an arbitrary scale, and as auxiliary values for the reduction to wave-lengths are not supplied, these communications have almost an exclusive interest for their author.

From what follows it may be seen that didymium consists of more than two components. As the spectrum of didymium nitrate is made up of a rather great number of lines, the undertaking to infer the number of the component elements of didymium from the nature of its spectra in different minerals and fractions is laborious. To facilitate it we gave up, for the present, the attempt to establish the relation of several lines, which appeared but faint, or very faint, to other didymium lines. As for the relative intensity of the more strongly visible absorption-bands, it will be more convenient, on account of the great number of lines, if we express their relative intensity by numbers instead of words. Let 1 stand for very strong, 2 for strong, 3 for rather strong, 4 for rather faint, 5 for faint, and 6 for very faint.

If the intensities are always in the first place compared with one of the didymium lines in the different cases observed it will be seen that the relative intensities of almost all didymium lines in the different spectra are variable.

The intensities of $\lambda=728{\cdot}3 : \lambda=679{\cdot}4$ in the spectrum of euxenite (Hitterö), Fraction I., are as 2 : 2, but in the holmium material as 3 : 2; $\lambda=728{\cdot}3$ and $\lambda=679{\cdot}4$ cannot, therefore, belong to the same body; the substance whose nitrate produces $\lambda=679{\cdot}4$ does not occur at all in the holmium material. From an analogous comparison of the intensities of the other lines with those of $\lambda=728{\cdot}3$ in the different cases it results that $\lambda=728{\cdot}3$ does not belong to a unitary body in common with any of the other didymium lines, and that its presence in the spectrum always shows the presence of a peculiar element in the substance examined.

If we compare the intensities of the other bands with those of all the other didymium lines mentioned we must, after examining the above table, form the opinion that at most $\lambda = 679{\cdot}4$ and $\lambda = 512{\cdot}2$, $\lambda = 579{\cdot}2$ and $\lambda = 575{\cdot}4$ belong together. All the other didymium lines are due to the absorption of the nitrates of different elements, as the proportion of their intensities is very variable. It would lead us too far to discuss at length all the relative intensities of the individual lines; their changing relations appear sufficiently from the table below.

As for the lines $\lambda=679{\cdot}4$, $512{\cdot}2$, $579{\cdot}2$, and $575{\cdot}4$, we see from the above that the proportion of the intensities of $\lambda=579{\cdot}2$ and $\lambda=575{\cdot}4$ is always the same; $\lambda=575{\cdot}4$ is always to be seen where $\lambda=579{\cdot}2$ occurs, and the latter is always stronger than the former. We have, therefore,

In the spectra of—	The following didymium lines have the following relative intensities.									
$\lambda=$	728·3.	679·4.	579·2.	575·4.	521·5.	512·2.	482·0.	469·0.	445·1.	444·7.
Thorite of Brevig	3	5	4	5	6	5	6	4	1	1
Thorite of Arendal, K_2SO_4 precipitate	1	5	1	1	2	5	2	2	2	2
Wœhlerite of Brevig	2	5	2	3	2	6	3	2	2	1
Cerite of Bastnäs	2	3	1	1	1	5	2	2	—	1
Samarium material	—	—	5	6	6	—	—	—	—	2
Praseodym material	2	6	2	3	3	5	4	3	—	1
Fergusonite of Arendal, Fraction I.	2	6	1	2	2	5	—	6	—	5
Fergusonite of Ytterby	3	6	1	2	2	5	—	6	—	5
Euxenite of Hitterö, Fraction I.	2	2	1	1	2	1	1	2	—	1
Holmium material	3	—	—	—	5	—	6	6	—	—
Euxenite of Arendal, Fraction I.	2	6	1	2	3	4	3	—	—	3

no reason to doubt that $\lambda = 579{\cdot}2$ and $575{\cdot}4$ are produced by the absorption of the nitrate of a unitary body.

As regards the possibility that $\lambda = 679{\cdot}4$ and $512{\cdot}2$ belong together, we refer to the first fractions of the fergusonite of Arendal; $\lambda = 679{\cdot}4$ increases in strength from Fraction I. to III., whilst $\lambda = 512{\cdot}2$ declines rapidly in intensity from Fraction I. to II. The oxides whose nitric solutions produce $\lambda = 679{\cdot}4$ and $512{\cdot}2$ behave, therefore, differently on the decomposition of their nitrates. Hence it does not appear possible to ascribe the lines $\lambda = 679{\cdot}4$ and $\lambda = 512{\cdot}2$ to one and the same element.

Ten years ago the "old" didymium was resolved into samarium and true didymium. From the above it appears that this didymium in all probability consists of not fewer than nine elements. At the same time it appears that Auer von Welsbach's neodymium and praseodymium are compound bodies. Further, it seems, according to the figures of the spectra of Auer's components of didymium, as if in his didymium material that body was present which we designate as $X\eta$.

Accordingly we are compelled to drop the names neodymium and praseodymium, and to designate the components of didymium as—

Symbol.	Characteristic lines. $\lambda =$
$Di\alpha$	728·3
$Di\beta$	679·4
$Di\gamma$	579·2 and 575·4
$Di\delta$	521·5
$Di\epsilon$	512·2
$Di\zeta$	482·0
$Di\eta$	469·0
$Di\theta$	445·1
$Di\iota$	444·7

As for the mutual connection of the didymium lines $\lambda = 708{\cdot}2$, $626{\cdot}1$, $591{\cdot}5$, $531{\cdot}3$, $530{\cdot}0$, $514{\cdot}6$, it has not as yet been ascertained, as they came out almost always very faintly. The authors propose, therefore, to call these lines by the general name Di.

Finally, they point out that on examining a didymium material from the cerite of Bastnäs, as well as of Cleve's didymium, the existence of a body was recognised, which cannot be identified with any of the other constituents of didymium. To the nitrate solution of this element there belong the absorption-bands $\lambda = 690{\cdot}5$, $\lambda = 525{\cdot}2$, and $\lambda = 434{\cdot}0$. All these the authors designate as Di.

(To be continued).

NOTICES OF BOOKS.

Coal-Tar and Ammonia. Being the Second and Enlarged Edition of "A Treatise on the Distillation of Coal-Tar and Ammoniacal Liquor." By George Lunge, Ph.D., Professor of Technical Chemistry in the Federal Polytechnic School, Zürich. London: Gurney and Jackson (Successors to Mr. Van Voorst).

That a second edition of Dr. Lunge's work should have become necessary is far from surprising; but we have here no mere reprint of the treatise in its original form. The enlargement mentioned on the title-page is a substantial reality. The letterpress has grown from 383 to 739 pages, and the number of diagrams has increased from 88 to 191. Even where no enlargement has taken place a very considerable portion of the book has been re-written. In fact, on comparing the two editions, we find the author fully justified in saying that there are but few pages in this new edition which have been taken unchanged from the former one.

Among the most important additions are the sections on the tar and ammonia obtained from coke burning, from blast-furnace gases, &c. Research and experiment in this direction have been lately much discouraged by the extremely low price of coal-tar and its products; but the increasing demand, of which our author makes due mention, will doubtless cause these attempts to be resumed. It is highly desirable that the manufacturer of coal-tar products may have at his disposal the greatest possible number of sources of his raw material. It is further very important that the by-products of the coke manufacture should be arrested and utilised instead o —as was formerly the case—escaping into the air and creating a nuisance. These objects have to a great extent been realised by the improved coke-ovens, those especially of the Simon-Carvès system. The utilisation of the volatile products has been greatly retarded on the Continent, and still more in England, by the belief that coke manufactured in other than the old bee-hive ovens was unfit for metallurgical uses,—a prejudice which has only gradually been overcome.

The tars, too, obtained in the earlier attempts at recovery, were of a very poor quality, and could scarcely pay for the expense of collection. A sample made at the Bear Park coke-works with Simon-Carvès ovens is of a fairly useful quality, and approximates not remotely to retort tars. According to the results here quoted from the *Journal of the Iron and Steel Institute*, the authority being Mr. Watson Smith, 1 ton of tar yielded 1·44 gals. of a 50 per cent benzol and 48·2 lbs. of a 28 per cent anthracene.

Dr. Lunge discusses the bold proposal thrown out by the late Mr. Weldon and others, that alkali-makers and other manufacturers in the coal districts, instead of feeding the raw coal into their furnaces, should convert it into coke, using the latter, *plus* the gas evolved, as fuel, whilst the tar and ammonia were to pay for the small coal consumed, so that they would get their fuel for nothing. Dr. Lunge pronounces this a splendid conception, but considers its practicability more than doubtful. So eminent an authority as I. Levinstein, indeed, holds that Weldon's proposal might succeed where the weekly consumption of coal does not fall below 300 tons, and if the coal gas is deprived of its benzol by the action of a fatty absorbent; but the author contends that such absorption processes are still on their trial. M. Scheurer-Kestner calculates the loss of heat-producing power in converting coal into coke and gas at 19·3 per cent.

Many varieties of coal-tars and natural tars, as it is here pointed out, are rendered worthless for the colour-maker by the presence of paraffin and kindred substances of the fatty series. An industrial method of separating these paraffinoids from the benzenoids is a desideratum.

We can only give a passing glance at the improvements —actual or prospective—in the manufacture of ammonia. It is here stated that if the furnace-gases of Scotland alone could be treated for the recovery of ammonia, an annual yield of 18,000 tons of ammonium sulphate would be secured. In the sewage of London there is wasted yearly, in the form of urine, ammonia capable of yielding 60,000 tons of sulphate. But the process which shall recover this valuable matter on commercial terms has yet to be discovered. None of the many methods proposed for obtaining ammonia, or indeed cyanogen or nitric acid, from the nitrogen of the atmosphere, has as yet gone beyond the experimental stage.

The first edition of this book was, we believe, without a rival in its own department; that now before us is of very much greater value, and will sufficiently recommend itself to all competent judges.

A New Dictionary of Chemistry, illustrated with Figures inserted in the Text, comprising its Applications to the Sciences, the Arts, to Agriculture, and to Industry. ("Nouveau Dictionaire de Chimie, illustré de Figures intercalées dans le Texte, comprenant les Applications aux Sciences, aux Arts, a l'Agriculture, et a l'Industrie.") By Emile Bouant. Part I. A—Chaleur, with 84 figures. Paris: Baillières et Fils.

A dictionary even of pure chemistry alone, like, *e.g.*, that of Watts, is in our days an arduous undertaking

but the programme of M. Bouant's work is much more daring, covering as it does the entire field of technical or applied chemistry. So far, however, as we can judge from the Part before us,—240 pages in double column,—the bulk of the articles will not be treated at very great length. To this, however, there are exceptions. Thus the ceramic or fictile art is treated of at great extent and illustrated with eleven figures, most of which refer not to the chemistry of pottery, but to its æsthetic aspect. On the other hand, the aniline colours can scarcely be said to have received a share of attention proportionate to their industrial importance. Aniline black is described in such a manner that its invention would seem due to one Lucas.

Under Acidimetry, Alkalimetry, and Volumetric Analysis we find mention of no indicators other than litmus, cochineal, and rosalic acid.

The metal cæsium and its compounds have been altogether overlooked.

Under Beer we find a remarkable statement:—"The bitterness of the hop is intensified by the addition of calumba root (*Cocculus indicus*) and *Faba amara*." It will surprise the reader to find *Cocculus indicus* given as a synonym for calumba root.

The fraudulent use of nitrobenzine in confectionery is duly mentioned, but there is no reference to its occasional introduction into wines.

Under "Acaroid Resin," the product of *Xanthorrhea hastilis*, which yields picric acid on treatment with nitric acid, we find it stated that this might be an advantageous method for the production of picric acid. Surely the author must be aware that this process has been abandoned as less remunerative than the use of phenol as a raw material.

The article on Bleaching is relatively brief, and has the disadvantage of not being illustrated.

It seems confusing to hear fustic spoken of as "Bois de Brésil jaune," since it does not come from Brazil.

Under Spermaceti we find mention of a fraud, certainly disgusting and possibly dangerous, *i.e.*, the addition of adipocire,—a product of the decomposition, under peculiar circumstances, of human and other animal bodies.

It is scarcely possible to form, from this one Part, a full and fair notion of either the merits or the defects of the entire work. If, as the Preface announces, it will be completed within two years, it will not require the reiterated appearance of supplements.

CORRESPONDENCE.

EXAMINATION OF OILS.

To the Editor of the Chemical News.

Sir,—I propose to follow Mr. Allen's remarks on this subject in the same order as referred to in his letter (Chemical News, vol. lvi., p. 149).

I am quite aware that sesame oil is used in making butterine, but its use is restricted, chiefly on account of its price. Mr. Allen says that, "in America, cotton-seed oil is the fluid oil chiefly employed for the purpose in question; but I believe this is not the case in Europe, where sesame oil and arachis oil seem to be preferred." I know that cotton-seed oil is extensively used in America, and that some makers of oleomargarine in this country press their own cotton-seed for this purpose. I also know of more than one maker of butterine who use large quantities of cotton oil and nut oil. Although some other oils are suitable for this purpose, as regards freedom from taste and smell and non-liability to become rancid too soon, I think the only oils at present used are sesame oil, cotton oil, nut oil, and niger oil. Of these cotton oil is most largely used, as far as I am aware of.

Mr. Allen next refers to another paper of mine on the "Adulteration of Oils." I quote from this paper and emphasize the remark that, "with a few trifling exceptions, all that appears from time to time in our chemical journals may be found in Chateau's "Corps Gras Industriels" (1864) and Fontenelle's "Manuel d'Huiles" (1866). Mr. Allen then gives ten methods, and says that "all or nearly all of the foregoing methods of examining oils have been devised or perfected within the last twenty years, and the majority of them within the last eight or ten, and hence could not have been described, or even foreshadowed, in books published in 1864 and 1866."

I am willing to admit that Mr. Allen's acquaintance with the literature of the subject is, on some of these methods, far in advance of my own.

Method 2.—Ascertaining the saponification equivalents of oils. If Mr. Allen will refer to page 19 of Fontenelle's work (1886) I think he will admit that this method was decidedly foreshadowed in 1866.

Method 6.—I do not know who first proposed iodine, but the use of this reagent is given in Chateau's work already referred to. There is certainly a very little to claim in using bromine for iodine.

Method 8.—The rise of temperature noted by Maumené, when sulphuric acid is added to an oil was published in 1852, and as the results of Maumené and others occupy thirteen pages of the "Manuel" by Fontenelle (1866), I may be excused dealing with this method further.

Method 9.—The determination of glycerin, &c. The claim raised here ignores what we owe to Chevreul, who has been rightly styled the "father of fatty chemistry," and who indicated that the amount of glycerin from the same oil should be constant.

Method 10.—The determination of the higher alcohols in sperm and bottle-nose oils, and of hydrocarbon oils in fatty oils generally. On these points I am certainly not acquainted with a satisfactory method of procedure. Specific gravity, consumption of oil in a given time, under a fixed illuminating power, have been for many years in use; more recently their lubricating power and viscosity are taken as indicating the purity of oils as lubricants. Experiment in this direction is more eloquent than words. I have been informed of a Company who saves at least £300 per annum on sperm oil and about £800 per annum on ordinary lubricating oil. Analysis and experiment alone have led to this result.

I have no practical acquaintance with the other methods mentioned by Mr. Allen, except that I use a different reaction for the presence of free acids, and determine the specific gravities of substances likely to contain air, by methods which are reliable but not mentioned. I find that the separation of fatty substances from resins and rosin oils can be carried out by the method given on page 415 of Fontenelle's book, and is especially valuable when a sample of colza or refined rape oil is mixed with rosin oil. Chloride of sulphur will effect their separation perfectly.

I have found this reagent so reliable with some oils that I have no hesitation in rejecting an oil which does not give the characteristic result. The systematic application of this reagent is being studied and worked out by Mr. E. Bruce Warren, principally in connection with butter adulterations and substitutes.

I am quite aware of the imperfect way in which chloride of sulphur has been referred to by me. Mr. Allen says "my experience of chloride of sulphur leads me to believe it to be badly adapted for such a purpose, as in my hands the extent and rapidity of its action on an oil varied in an obscure manner under conditions apparently identical."

I shall be very pleased, as soon as the application of this test is properly worked out, to send particulars of the same to the Chemical News.

I may just add that there is a great difference in chloride of sulphur, and that there is a very curious difference in its action on different oils. The yellow chloride should be used, and diluted with bisulphide of car-

bon or petroleum spirit; about equal volumes will be convenient for general use, but a much higher dilution is necessary in the case of castor oil. The reaction sets in as the solvent evaporates, which takes place by spontaneous elevation of temperature, assisted, if necessary, by a very gentle heat.—I am, &c.,

THOMAS T. P. BRUCE WARREN.

Tamworth Villa, Earlham Grove,
Forest Gate, E.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 12, September 19, 1887.

The Reduction of Alumina.—G. A. Faurie.—We take two parts of alumina very pure and finely powdered, and make it into a paste with 1 part of petroleum. This paste, well beaten up, is mixed with one part of sulphuric acid. When the yellow colour is uniform and the mass homogeneous sulphurous acid begins to escape. The paste is then wrapped up in paper and thrown into a crucible heated to full redness, above 800°, so as to decompose the petroleum. The flame is let go out and the crucible is cooled. The compact product obtained is carefully powdered and mixed with an equal weight of a metal in powder. This mixture is placed in a graphite crucible, well closed, and the crucible is heated to whiteness in a blast furnace. It is then let cool and opened. Among a black metallic powder there are found grains and alloys of alum nium. This process is applicable also to silica, lime, magnesia, &c.

Moniteur Scientifique, Quesneville.
Series 4, Vol. i., May, 1887.

Contributions to the Study of the Products of the Saccharification of Starch.—Dr. J. Effront.—The progress of the transformation of starch into sugar and dextrine differs according as it is effected by means of malt or by means of an acid. In saccharification by malt the starch molecule is split up into dextrine and maltose. Saccharification by an acid is characterised by the transformation of starch into dextrine, and that of the latter into glucose. The dextrines obtained by these two methods are not identical. Those resulting from saccharification by malt are polymeric; those resulting from the acid process are not so, but all have always the same rotatory power. In the acid process there is always formed maltose to the extent of 34 to 38 per cent of glucose. In saccharification by malt the formation of glucose is not regular. In liquids of low specific gravity glucose is formed if the infusion of malt employed is turbid. Dextrine is obtained in a state of purity on destroying the sugar by the lactic fermentation. For analysing the products of the saccharification of starch the author proposes a method which consists in destroying the sugars by ammonia and sodium hypochlorite, and determining the dextrine by the deviation of the liquid before and after treatment.

On the Homologues of Aniline and their Industrial Separation.—Dr. O. N. Witt.—The author remarks that there is a well-marked tendency in industrial chemistry to reject the heterogeneous products which were formerly used as starting-points; benzene, toluene, aniline, the nitrotoluenes, and toluidines are now required and produced in a pure state, and probably in a few years the xylenes, nitroxylines, and xylidines will also be demanded in states of isolation.

Manufacture of the Colouring-Matters of the Eosine Group.—Dr. Otto Muhlhauser.—The author gives here in full detail instructions for the manufacture of fluoresceine, soluble eosine, eosine B, eosine A extra, eosine orange, spirit eosine, safrosine, erythrosine B, soluble primrose, erythrosine G, and dianthine.

Analytical Detection of Saccharine.—From the CHEMICAL NEWS.

Synthetic Formation of Closed Carbon Chains.—Dr. W. H. Perkin.—From the *Journal of the Chemical Socity.*

Composition of Neutral Quinine Chromate.—Dr. O. Hesse.—From the *Pharmaceutical Journal.*

Assay of Quinine Sulphate by Potassium Chromate.—Dr. O. Hesse.—From the *Pharmaceutical Journal.*

Determination of Carbon, Hydrogen, and Nitrogen, in Organic Matter in a Single Operation.—Paul Jannasch and Victor Meyer.—This paper will be inserted in full by opportunity.

On Calcium Borate.—B. Blount.—From the CHEMICAL NEWS.

MISCELLANEOUS.

An Appeal.—We feel justified in bringing the following case before our readers, believing that many will be glad to aid. The main facts are vouched for by Mr. R. Forbes Carpenter, of Prestwich, Manchester. It is right to add that the sufferer shrank from the idea of this appeal, and that the responsibility of it rests upon a few Fellows of the Chemical Society. Mr. Charles Moon was for six years Chemist in the Laboratory of the Spence Brothers Chemical Company, Limited. In 1884 the Works were closed, and at about the same time Mr. Moon—at the age of 31—became blind through rheumatism. He himself, his wife, and two children were thus rendered destitute. Some members of the Society of Chemical Industry came forward, and Mr. Moon tried first in Manchester, and afterwards in Birkenhead, to get a living by trade. These attempts have unfortunately failed, and the ill-fated family are now in urgent distress. Several ophthalmic operations have already been performed, and a few more will be necessary; but there is now every hope that before long Mr. Moon will recover his sight, and with it the power of supporting his family. Chemists will not allow a brother Chemist to sink under a misfortune which, however terrible, seems likely to be temporary, and we have no doubt assistance will be afforded. We shall be happy to take charge of subscriptions and forward them to the recipient.

New Work.—Messrs. Macmillan are about to publish a "Course of Quantitative Analysis for Students," by Prof. W. N. Hartley, F.R.S. The text-book consists of 44 exercises in mineral analysis practised by the students of the Chemical Laboratory of the Royal College of Science, Dublin. Water analysis, gas analysis, and assaying are not specially treated, as there are already works designed to teach these subjects, but the examples are selected with a view of teaching the principles of chemical analysis, beginning with very elementary determinations, and passing onward, step by step, to the analysis of complicated and refractory silicates.

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OUTLINES OF ORGANIC CHEMISTRY,

By H. FORSTER MORLEY, M.A., D.Sc.,

Fellow of, and Assistant-Professor of Chemistry at, University College, London.

J. and A. CHURCHILL, 11, New Burlington Street.

TO MANUFACTURING CHEMISTS AND OTHERS.

THE METROPOLITAN BOARD OF WORKS will meet at the Office of the Board, Spring Gardens, S.W., on FRIDAY, the 21st day of OCTOBER, 1887, at Twelve o'clock at noon precisely, and will then be prepared to OPEN TENDERS by parties who may be willing to contract for the supply of 500 tons of MANGANATE OF SODA.

Parties desirous to submit Tenders for the supply of the whole or part of the foregoing quantity may obtain a copy of the Specification, form of Tender, and information of the places and periods of delivery, on application to the Chemist of the Board, at the Office, Spring Gardens, between the hours of Nine a.m. and Four p.m. (on Saturdays between the hours of Nine a.m. and Two p.m.), until Thursday, the 20th day of October, 1887. The Tenders, which must be on the form supplied from this Office, and addressed to the Clerk of the Board, are to be delivered at the Office before Four o'clock on the last-mentioned day, and no Tender will be received after that hour. The parties tendering must be in attendance at the Board at Twelve o'clock on the day appointed for opening Tenders, and any Tender which is not fully filled up in every particular will be rejected. The Board do not bind themselves to accept the lowest or any Tender.

J. E. WAKEFIELD,
Clerk of the Board.

Spring Gardens, S.W.,
11th October, 1887.

American Exhibition closes October 31st.

PROF. A. E. FOOTE would call the attention of the friends of the numerous teachers, professional men, and amateurs, that have favoured him with their custom, to the fact that but a short time remains in which they can avail themselves of the remarkable opportunity of adding to their collections choice American Minerals at low prices.

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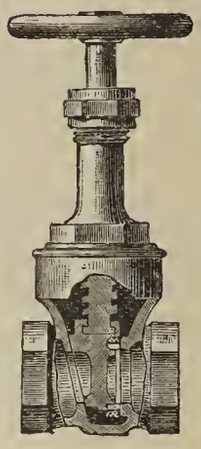

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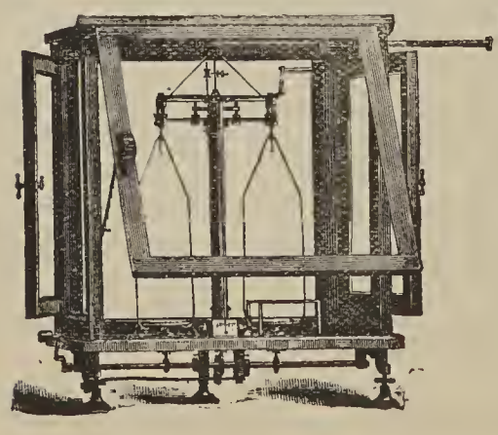

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THE CHEMICAL NEWS.

Vol. LVI. No. 1456.

THE RELATION OF SCIENCE TO THE STATE.

V.

We have shown, by an appeal to the stern logic of facts, that the position of Science in these realms is not what our national interests demand. In searching for the causes of this discreditable shortcoming we have referred to the hostility of the *cui bono* fraternity, whether utilitarians or ethicists. We have reminded our readers of the unremunerative character of original research under conditions prevalent in this country. We are told, indeed, by an author whom we have already quoted, that a scientific writer may earn from £2000 to £5000 annually by his works. Accepting, for argument's sake, this assertion, though it is sufficiently rose-coloured, we must note the proviso that the qualities required for popular scientific writing are the same as those which tell for works of fiction! How many of our most eminent *savants* possess this rare combination of faculties? How many of them could devote so much time and attention to mere pen and paper work? For how many of such authors would there be an opening?

Mr. Proctor mentions "scientific education" as one of the methods by which a man devoted to research may earn a livelihood. Doubtless this is the case in Germany, where a man climbs to the professorial chair by important and fruitful investigations which he has carried out, and where he is afterwards valued in proportion to the number of discoveries which he and his pupils bring forward. But in England all this is different: the Science teacher stands or falls not by the contributions to human knowledge effected in his school, but by the number of students whom he can get to "pass." And as research thus counts for nothing, it is valued at nothing.

Nor does the estimation in which even the most illustrious man of science is held by the nation or by Government at all compensate for the scantiness of more tangible rewards. There is no position of honour which can be won by research, and research only. The average John Bull is too apt to despise any man who does not make his fortune, and to argue that pursuits which do not enrich their especial followers can be of little value to the nation.

As for the honours which are supposed to be open to eminence of any kind, they appear to be withheld on principle from men of Science. Within the memory of the present generation four peerages have been awarded to Literature, and to Law a number greater than we care to calculate. Upon pure Science even a baronetcy or a knighthood is rarely bestowed. Yet it can scarcely be denied that a man like Faraday did more to raise England in the estimation of foreign nations than all the lawyers who ever pleaded at the Bar or gave decisions on the Bench.

But, leaving titles and orders on one side, there are other marks of honour which rarely fall to the lot of scientific men. Seldom are statues erected to their memory in any public place, and seldom are streets called by their names. As a very striking instance of cold indifference to the claims of Science we may single out the funeral ceremony of Charles Darwin at Westminster Abbey. No member of the Royal family was present, personally or by a representative. It may be said that such honours are barren; we cannot admit this assertion. They are an encouragement to the young student. Those of them which are not of a *post mortem* character are indirectly, but nevertheless decidedly, remunerative. The works of a titled *savant* would be more readily accepted in the "Row," and more eagerly bought by the public than if he had remained plain Mr. A. B.

Of course in all these points our national policy is in full contrast with that of our most formidable rivals. *They* find the encouragement of Science advantageous. We refuse to learn from their successes. Even in these innovating days we keep, in this respect, to our old paths. "Justice to Science" is not a catch-word which will influence a contested election, and—shall we say in consequence?—it is raised by neither party. There are, on both sides of the House, men who admit and regret our present position, but so far they show no disposition to do anything better than to institute new examinations to be "passed."

We fully admit that Government interference is a very delicate matter. Judging from the past we fear that there is too much truth in the humiliating confession made not long ago by the Earl of Derby, that such interference would be pernicious.

But Government interferes already—not in favour of, but against, research!

This interference takes place in a variety of ways. There is, at any rate, one direct enactment which seriously cripples investigations, not merely in biology, but in certain departments of chemistry.

Government has instituted, still upholds, and threatens to extend a system of higher education which is formally unfavourable to scientific research. Such research is in its spirit entirely opposed to a system which turns essentially upon competition. The true investigator never asks or cares whether he knows anything better than some other person. Such "other person" never crosses his thoughts at all. He sees before him merely the unsolved problems which Nature presents us, and he throws himself upon some one of these heart and soul. Said Prof. Rolleston—"One result of our present examination-system is that men who, . . . during the whole of their university career, are subject to the ordeal of examinations *in futuro*, . . . do not look upon what they have under study as so much truth, but look upon it as something to be reproduced upon paper. When a man is kept for many years of his life under that sort of training, he gets apt to look at all work whatever of the intellectual kind from the point of view of the examination merely. Men get demoralised by the process. They do not look at the truth for itself. They have no notion of pushing forward the elements of knowledge into some area into which nothing has been before."

Says Mr. Arthur Holmes, of Clare College (Cambridge)—"Examiners were the feature of this age, and they were getting intolerable."

Mr. Archibald Sayce, Fellow of Queen's College, Oxford, says:—"Competitive examination and original research are incompatible terms. The object of the one is to *appear* wise, the object of the other to be so."

Method Proposed for Destroying the Phylloxera—Dr. Clemm has patented the following process in most civilised countries:—He incorporates with the soil sulphides and carbonates which easily undergo decomposition, preferably those of potassium. Peat, which has been made to absorb sulphuric, nitric, or phosphoric acid, is then also introduced. The acid gradually acts upon the sulphide and the carbonate, liberating sulphuretted hydrogen and carbonic acid in the soil. These two gases, according to the experiments of Dr. Eyrich, of Mannheim, are rapidly and uniformly distributed, and prove fatal to the *Phylloxera* in its underground stage, as well as to Colorado beetles, field mice, moles, &c. The potash remains in the soil as a sulphate, nitrate, or phosphate. The only question is whether useful animals, such as earthworms, humble bees, carnivorous ground-beetles, &c., will not be destroyed also?

ON DEEP SEA DREDGINGS.

By THOMAS T. P. BRUCE WARREN.

In the article which appeared in the Chemical News, vol. lvi., p. 151, on "The Relation of Science to the State," the following paragraph appears :—

"Another proof of our shortcomings may be found in the rarity of our scientific exploring expeditions by land or sea. Since the memorable voyage of the *Challenger* nothing of an extensive systematic character has been undertaken either under the auspices of Government or of private individuals. Nor must we forget that the staff of the *Challenger* was in part recruited abroad, and that the collections made and other crude results obtained were not entirely worked out at home. Some of them were committed for this purpose to Prof. Baury, of the University of Strasburg."

I have often wondered that simple chemical analyses should have been handed over to a foreign university, however distinguished. I would venture to say that any tyro in analysis, who was well up in accurate and careful manipulation, could have made the analyses of the "bottoms" picked up by this expedition with equal precision and with no less definite meaning for biological or geological renderings.

At present it passes my comprehension that a nation holding first rank as a naval power, possessing, too, the finest commercial fleet, and which has constructed and laid the submarine telegraph cables of the world, should be disposed to go to another nationality (which at this time could hardly boast of a mercantile marine) for the analyses of deep sea dredgings!

"Spectatum admissi risum teneatis amici?"

What warrant is there to justify the making of chemical science the scape-goat of the naturalists and microscopists who organised this part of the expedition.

A notion has gained currency that *hundredweights* of interesting dredgings have been brought to light, and that anyone getting a little of them *to work upon* may discover something which the *Challenger* scientists may have missed.

If there is any truth in this we have a right to ask whether it is fair or even honest to sacrifice the chemical reputation of this country to the mere sentiment of priority? Would it not have been wiser, at least, to have distributed portions of these dredgings to those who would appreciate their microscopical and chemical importance?

I should be sorry to say anything disrespectful of Germany; let us not forget Prof. W. A. Hofmann and what he did for us. I have no hesitation in saying that this country possesses naturalists, geologists, and chemists quite capable of doing what others have done for us; at at any rate, having formed an idea of what was intended to be carried out, there would have been no difficulty in training an efficient staff of operators in a few weeks, quite equal to any duties likely to arise on this expedition, or even of a higher intellectual stamp.

It is not too late to raise the status of our chemists as scientific men. Natural history and microscopy are at present hardly recognised as parts of a scientific curriculum, still those who are hostile to our reputation must admit that we are justly proud of our naturalists.

In making microscopes it would be affectation to place English and German instruments on the same level of excellence. Even the Americans turn out better objectives than the Germans. A fact worth noting is that, although the Germans have been working for some time past to improve the quality of their glass for objectives, we are able, even when using their own "metal," to turn out objectives much superior to their production.

I can imagine that a critic may say that this is no sign of superior handling; a man with an inferior instrument may, no doubt, do much better work than another working with a high class instrument. All I can say is, that the value of an observer in scientific microscopy is measured by the optical performance of his instrument.

Although there is a tendency to disparage our national merit in certain branches of science, I think that we need not fear who enter the lists against us as competitors.

What seems to me the main thing to be attained is the establishment of some channel for ventilating or discussing what may be called the "odds and ends" of science, subjects which, in fact, according to the etiquette of our learned societies, are not considered as suitable subjects.

If the Chemical Society were to have sections for considering chemistry in connection with branches of science which are not purely chemical, but which involve philochemical research, an important object might be gained, but on this matter others are better able to form an opinion than myself.

On a future occasion I propose to deal with this subject from a chemical point of view, although thermometry and microscopy can hardly be regarded as beyond range.

ON THE COMPONENTS OF THE RARE EARTHS GIVING ABSORPTION-SPECTRA.

By GERHARD KRÜSS and L. F. NILSON.

(Concluded from p. 167).

5. *On the Components of Samarium.*

The name samarium was introduced by Lecoq de Boisbaudran for an element which was identical with Marignac's $Y\beta$, and which was also a constituent of the "old" didymium. According to measurements effected by Thalén with a preparation of Cleve's, samarium nitrate displays seven absorption bands in the easily visible part of the spectrum. As to the band $\lambda=445-437$ it is probably identical with the somewhat unsymmetrical lines given in the above tables as $\lambda=445{\cdot}1$ and $444{\cdot}7$. These were ascribed to didymium, as they were very strongly manifest in the spectra of many materials which were rich in the constituents of didymium, though no other samarium lines were visible

The relative intensities of Thalén's other Sm lines will appear from the subjoined table. (See next page)

If we next observe $\lambda=416{\cdot}7$, this line occurs in many cases about as strong as $\lambda=477{\cdot}7$ and $\lambda=463{\cdot}2$. It is, however, surprising that $\lambda=416{\cdot}7$ is to be seen rather strong, strong, and even very strong, in the spectra of thorite from arendal, euxenite from the same locality (Fraction III.), and of holmium material, whilst no other Sm line is visible in the spectrum. In these mixtures of earths there is therefore a body whose nitrate produces in the spectrum merely the line $\lambda=416{\cdot}7$, and which we may call Sm_α; all the other samarium lines must be ascribed to a $Sm\beta$.

According to the above investigations we must, in place of erbium, holmium, thulium, didymium, and samarium, admit the existence of more than 20 elements. As the sum of the samarium spectrum, together with Auer's neodymium and praseodymium bodies, is equal to the spectrum of "old" didymium, just so the sum of the spectra of the above-mentioned components of the rare earths makes up the spectrum of the latter. In the above memoir we have proceeded on the principles according to which the compounds of samarium are spectroscopically distinguished from those of neodymium and praseodymium. According to our present knowledge about the samarium and didymium compounds we cannnot doubt that they are compounds of two distinct bodies. Were we to assume that the three different spectra of samarium, neodymium, and praseodymium did not correspond to the xistence of three completely independent bodies, but was

In the spectrum of the earths from—	The relative intensities of the samarium lines were— λ = 559—556.	501·5—497.	477·7. (486—472).	463·2. (466—460).	416·7.	409.
Thorite from Brevig	—	—	Faint.	Faint.	Faint.	—
„ from Arendal, fraction of yttria earths..	—	—	—	—	Rather strong.	—
Wœhlerite	—	—	Faint.	Very faint.	Very faint.	—
Cerite of Bastnäs	—	—	Faint.	Very faint.	Faint.	—
Samarium material	Faint.	Rather strong.	Very strong.	Very strong.	Very strong.	Faint.
Fergusonithe of Arendal { Fract. I.	—	—	—	Very faint.	Very strong.	—
„ III., IV...	—	—	—	—	Rather strong.	—
„ V.	—	—	—	—	Rather faint.	—
Fergusonite of Ytterby	—	—	—	Very faint.	Strong.	—
Euxenite of Hitterö { Fract. I.	—	—	Strong.	Strong.	Very strong.	—
„ IV.	—	—	Faint.	Strong.	Very strong.	—
„ VII...	—	—	Very faint.	Rather strong.	Rather strong.	—
„ VIII.	—	—	—	Faint.	Rather strong.	—
„ X.—XI.	—	—	—	—	Faint.	—
Holmium material	—	—	—	—	Very strong.	—
Euxenite of Arendal { Fract. I...	—	—	—	Rather faint.	Strong.	—
„ III.	—	—	—	—	Strong.	—

due to three different combinations of only two independent bodies which should depart too far from the basis of facts, and should be obliged to call to help many hypotheses. The same would be the case were we to assume, *e.g.* that holmium consists not of 7 but only of 2 components. Such hypotheses would have a very arbitrary character. Hence we have been guided by the simpler views which, during the last ten years, have proved so fruitful in the decompositions and separations of the gadolinite and cerite earths.

The above accounts of the spectra of the earthy mixtures, may perhaps give hints in what minerals this or the other rare earth may be found in relatively considerable quantities. The authors then give the accompanying conspectus of all the 40 lines observed in the above researches in the spectra of the nitrate solutions of rare earths.

As for the position of the elements of the rare earths in the periodic system, they probably belong chiefly to the middle series; perhaps in time it may be necessary to increase the number of these series. According to Mendeleeff elements closely allied to each other should find their place in the middle of the system, those most analogous being the closest together. Further speculations would be premature. The authors finally express the hope that many chemists may be found to take a share in cultivating a department which requires the united efforts of many investigators.—*Berichte der Deutch. Chem. Gesellschaft*, Vol. xx., Part 12, p. 2134.

Wave-lengths of maximum darkness.	Symbols of elements.	Remarks.
728·3	Di_α	In spectra of ytterbia mother-liquors, and of the euxenite of Arendal, Fract. VIII.—XIV.
716·4	?	
708·0	Di	
690·5	Di_κ	
684·0	Tm_α	
679·4	Di_β	
654·7	Er_α	
640·4	X_α	
626·1	Di	
591·5	Di	
579·2	Di_γ	
575·4	Di_γ	
558·6	Sm_β	
542·6	X_β	In spectra of holmium materials; in earths from wœhlerite and thorite of Brevig.
539·9	?	
536·3	X_γ	
533·6	?	In euxenite of Hitterö and fergusonite of ytterby.
531·3	Di	
530·0	Di	
525·2	Di_κ	
523·1	Er_β	
521·5	Di_δ	
514·6	Di	
512·2	Di_ϵ	
500·4	Sm_β	In spectra of earths from wœhlerite and thorite of Arendal.
488·8	?	
485·5	X_δ	
482·0	Di_ζ	
477·7	Sm_β	
474·5	X_ϵ	
469·0	Di_η	
465·0	Tm_β	
463·2	Sm_β	
452·6	X_ζ	
445·1	Di_θ	
444·7	Di_ι	
434·0	Di_κ	
428·5	X_η	
416·7	Sm_α	
409·0	Sm_β	

ON THE COMPOSITION OF WATER BY VOLUME.*

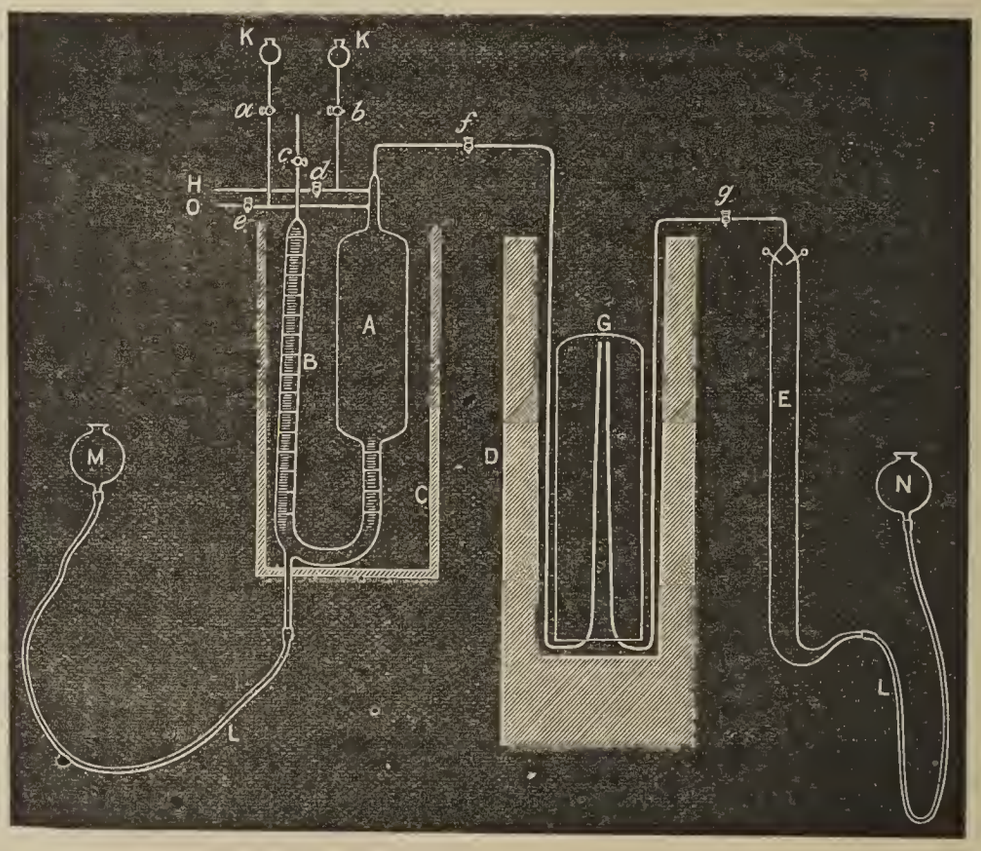
By ALEXANDER SCOTT, M.A., D.Sc.

In 1805 Gay-Lussac and Humboldt published their classical researches on the composition of the atmosphere, and to them we are indebted for our knowledge of the proportion by volume in which hydrogen and oxygen combine to form water. Without this knowledge the determination of the relative densities of the two gases would be of no use in fixing or checking their atomic weights. This is often overlooked, and Avogadro's law taken as absolutely true for these gases at ordinary temperatures and pressures. That this cannot safely be assumed is conclusively proved by the researches of Regnault, Amagat, and others on the effects of change of temperature and pressure upon them. Not only do they not follow Boyle's law as usually understood, but their deviations from it are in opposite directions, hence it can only be by the merest chance that at our ordinary temperatures and pressures the combining volumes should be exactly two of hydrogen to one of oxygen. Moreover, when we consider that it is more than eighty years since these researches were carried out, that the instrument used in all the measurements was Volta's eudiometer, and that the gases were collected and measured over water

* A Paper read before the Royal Society, June 16, 1887.

Experiment.	A. Measured volumes of		B. Residue after explosion.				C. Combining volumes, impurity being calculated as being in both in same proportion.		D. Combining volumes, all impurity being supposed to be in the oxygen.		E. Calculated from column C, 1 volume of oxygen combines with the following vols. of hydrogen.	F. Calculated from column D, 1 volume of oxygen combines with the following vols. of hydrogen.	G. Impurity in gas used (total).
	Hydrogen.	Oxygen.	Total.	Oxygen.	Hydrogen.	Impurity $N+CO_2$.	Hydrogen.	Oxygen.	Hydrogen.	Oxygen.			
I.	3757·1	1919·5	39·5	36·8	—	2·7	3755·3	1881·8	3757·1	1880·0	1·9956	1·9984	$\frac{1}{214}$
II.	3848·1	2028·7	104·4	94·5	—	9·9	3841·5	1930·9	3848·1	1924·3	1·9894	2·0000	$\frac{1}{618}$
III.	3902·0	2085·7	131·3	128·7	—	2·6	3900·3	1956·1	3902·0	1954·4	1.9934	1·9965	$\frac{1}{2470}$
IV.	3672·6	1921·9	63·4	35·0	—	28·4	3653·7	1877·4	3672·6	1858·5	1·9460	1·9760	$\frac{1}{203}$
V.	3841·5	1915·7	44·1	—	32·7	11·4	3801·2	1911·9	3808·8	1904·3	1·9882	2·0000	$\frac{1}{550}$
VI.	3667·9	1868·8	56·9	—	28·1	28·8	3620·6	1857·2	3639·8	1840·0	1·9494	1·9781	$\frac{1}{201}$
VII.	3685·9	1876·5	22·2	12·8	—	9·4	3679·6	1860·6	3685·9	1854·3	1·9776	1·9877	$\frac{1}{600}$
VIII.	3649·1	1891·5	61·1	52·8	—	8·3	3643·6	1835·9	3649·1	1830·4	1·9846	1·9936	$\frac{1}{683}$
IX.	3942·6	1997·0	18·8	12·5	—	6·3	3938·4	1982·4	3942·6	1978·2	1·9867	1·9930	$\frac{1}{949}$
X.	3861·3	1967·3	30·5	24·5	—	6·0	3857·3	1940·8	3861·3	1936·8	1·9875	1·9936	$\frac{1}{968}$
XI.	3799 7	1930·2	29·1	23·4	—	5·7	3795·9	1904·9	3799·7	1901·1	1·9927	1·9986	$\frac{1}{1018}$
XII.	3857·1	1948·2	19·4	15·2	—	4·2	3854·3	1931 6	3857·1	1928·8	1·9954	2·0000	$\frac{1}{1594}$
XIII.	3845·4	1954·9	25·0	20·5	—	4·5	3842·4	1932·9	3845·4	1929·9	1·9880	1·9926	$\frac{1}{1376}$
XIV.	3780·4	1907·4	12·2	9·0	—	3·2	3778·3	1897·3	3780·4	1895·2	1·9910	1·9950	$\frac{1}{1789}$
XV.	3898·6	1963·5	10·9	8·8	—	2·1	3897·2	1954·0	3898·6	1952·6	1·9945	1·9966	$\frac{1}{2801}$
XVI.	3910·2	2003·2	44·9	40·4	—	4·5	3907·2	1961·3	3910·2	1958·3	1·9920	1·9969	$\frac{1}{1830}$
XVII.	3965·5	2011·5	25·6	21·6	—	4·0	3962·9	1988·6	3965·5	1985·9	1·9928	1·9968	$\frac{1}{1511}$
XVIII.	4012·6	1975·9	79·3	—	77·2	2·1	3934·0	1975·2	3935·4	1973·8	1·9917	1·9940	$\frac{1}{2887}$
XIX.	4078·7	1964·0	184·7	—	178·2	6·5	3896·1	1961·8	3900·5	1957·4	1·9860	1·9926	$\frac{1}{948}$
XX.	4095·3	2008·6	87·8	—	84·5	3·3	4008·6	2007·5	4010·8	2005·3	1·9968	2·0000	$\frac{1}{1928}$
XXI.	3904·8	1964·5	27·8	—	12·5	15·3	3882·1	1959·4	3892·3	1949·2	1·9813	1·9968	$\frac{1}{894}$

The unit volume taken is that of a grm. of mercury at 16° C. The gaseous volumes are reduced to 0° C. and 760 m.m. pressure. The residue given in B was in all cases analysed by explosion with H or O. Column C gives the combining volumes if we assume the hydrogen and oxygen to be equally pure. Column D of course gives a maximum value to the ratio of the volume of hydrogen combining with 1 of oxygen. The gaseous impurity was almost entirely nitrogen with small quantities of carbon dioxide.



and so contained the impurities to the extent of 0·4 per cent in the oxygen and 0·6 to 0·8 per cent in the hydrogen used, a re-determination of this ratio with the greatly improved means for attaining accuracy now at our command seemed to be of extreme importance. The exact ratio as given in the memoir referred to is 199 89 volumes to 100 volumes of oxygen, and this the authors say is almost exactly as 2 : 1.

To arrive at greater accuracy the author of this note has given especial attention to the following points :—

(1.) The preparation of purer gases.
(2.) The use of larger volumes.
(3.) The measurement of both gases in the same vessel
(4.) The analysis of the residue after explosion and determination of the impurity in each experiment.

These ends were more or less satisfactorily attained by the use of apparatus employed, which was entirely of glass with the exception of the junctions at H and O. The gas generators contained only small volumes of gas, and could easily be exhausted by means of the apparatus itself. It is evident that by filling A and B with mercury, completely closing all the stopcocks, and then lowering M and opening *e*, the air in the oxygen generator would be in great part drawn into A; on now closing *e* and raising M this air could be expelled by opening *f*. By repeating this several times an almost perfect vacuum could be produced. Before collecting the gas for the experiments, after exhausting the air gas was evolved and exhausted, and this again repeated. The gases were measured, saturated with moisture, and after measurement were expelled into G; from this they were drawn into E and exploded, and the residue measured in a small tube and analysed by explosion with either hydrogen or oxygen as required. The results of every experiment made are given in the accompanying table, from which it will be seen that in no case, even when the maximum value is given to it, does the ratio exceed 2 vols. of hydrogen to 1 vol. of oxygen, although in four cases it is exactly 2 : 1.

The mean of the twenty-one experiments gives the ratio—

1·9857 : 1 from Column E.
1·9941 : 1 ,, F.

Excluding experiments IV. and VI., in which the gases contained much impurity, we get the ratio—

1·9897 : 1 from Column E.
1·9959 : 1 ,, F.

Taking experiments I., III., XV., and XVIII., in which the purest gases were used, we get—

1·9938 : 1 from Column E.
1·9964 : 1 ,, F.

or taking experiments I., III., XIV., XV., XVIII., and XX. we get—

1·9938 : 1 from Column E.
1·9967 : 1 ,, F.

Taking as the most probable ratio 1·994 : 1, and the density of oxygen referred to hydrogen as 15·9627, we get the atomic weight of oxygen as 16·01.

The oxygen was in each of the first twenty experiments prepared from potassium chlorate, and in the twenty-first from mercuric oxide prepared from the nitrate. The hydrogen was in each case prepared by electrolysis. The water produced was free from any acid reaction, and no trace of the oxides of nitrogen could be detected.

ANIMAL TANNIN.

By M. VILLON.

Hitherto there have been known only vegetable tannin with its 800 varieties, and synthetic tannin or digallic acid, not to speak of the so-called mineral tannin obtained from coal, peat, &c. The author has for a long time sought for an animal tannin,—*i.e.*, one formed in the organism of an animal, and appearing either in its secretions or in its tissues. Having been engaged with the weevils, well known from the damages which they occasion in granaries, he sought for tannin, knowing that as far back as 1810 M. Penunt, of Lyon, had found gallic acid in these insects.

The corn weevil (*Calandra granaria*) is a Coleopterous insect of about 3 millimetres in length, and of a maroon-brown colour. These insects were first killed by exposure to the fumes of chloroform, then ground up and digested for an hour in boiling alcohol at 90 per cent. The extract is decanted into a retort and evaporated down on the water-bath to a syrup, and finally dried in a capsule. The residue is taken up in acetic ether at 50°; the liquid is filtered, diluted with half its volume of water, and precipitated by means of ammoniacal zinc acetate, prepared by dissolving zinc acetate in liquid ammonia diluted with half its volume of water. The first and the last portions of the precipitate are rejected. The precipitate thus obtained consists of zinc tannate, other substances—such as gallic, ellagic acids, phlobaphine, albumenoids, and pectic principles—remaining in solution.

The precipitate is then suspended in water to which oxalic has been added sufficient to throw down all the zinc, The mixture is heated nearly to a boil whilst stirring. The tannin remains in solution; the liquid is evaporated to a syrup in a vacuum at a temperature of 50° to 60°. Five hundred parts of weevils yielded fifteen parts of pure tannin.

Animal tannin (fracticornitannic acid) appears in the form of small reddish yellow scales, soluble in water, aqueous ether, alcohol, chloroform, &c. It possesses all the general properties of the tannins, precipitating gelatin, albumen, and dissolved caseine, and being absorbed by animal tissues. It precipitates the natural and artificial alkaloids and gives a bluish black colouration with ferric salts. Its analysis leads to the formula $C_{28}H_{16}O_{16}$. Sulphuric acid splits it up into glucose, gallic acid, and an amorphous red product analogous to phlobaphene.—*Bull. de la Soc. des Elèves de M. Fremy.*

PROCESS FOR OBTAINING THE RARE EARTHS OF THE CERIFEROUS CLAYS OF HAINSTADT.

By Dr. JONES RUDOLPH STROHECKER.

Since the investigation of the material has passed the primitive stage described in my two first memoirs (*Journ. Prakt, Chemie*, 1886, pp. 132 and 260), and in consequence of criticism has been submitted to a special re-examination (Keim, *Techn. Mittheilungen*, Munich, 1886, Nos. 23 and 24, and *Chemisch. Centralblatt*, Sept. 1, 1886), the reason has come to light why in most cases cerium cannot be separated out in the ordinary manner, and it became in consequence requisite to find a satisfactory method for obtaining the rare earths of the cerite clays.

The cause why cerium generally escapes separation, and even observation, is the presence of ferric oxide,—if a cerite clay contains more than about 0·5 per cent of this substance, oxalic acid and potassium sulphate produce not the ordinary cerium deposits, but others rich in iron. The oxide obtained by means of caustic potassa from the alum precipitate is of a leather-brown, and retains this colour on ignition. It behaves like a very intimate combination of the oxides of iron and cerium, but its constitution is as yet unknown. This substance seems to have been at once taken for iron oxide by many chemists.

Very numerous separation-experiments were therefore undertaken, among which there occurs a crystallisation of cerous sulphate. Pointed pyramids were formed from a sulphuric solution of ferriferous Hainstädt cerium, and were examined by me and by a member of the University of Berlin. As further accelerated experiments in crystallisation gave a yield of crystals,—abundant, indeed, but not free from iron,—a purely chemical process had to be sought for. The following was found the most serviceable:—

The red cerite clay (No. 1) is boiled with pure hydrochloric acid until it is decolourised. The bituminous material is boiled for the same length of time. The fil-

trate is treated with potassa for the removal of silica, alumina, and glucina, and the washed precipitate (consisting of ferric oxide, cerium and lanthanum oxides, and possibly didymia, yttria, lime, magnesia, and phosphates) is re-dissolved in hydrochloric acid and mixed with potassium sulphide (not ammonium sulphide); phosphoric acid passes into solution, and all the earths are precipitated. They are again taken up in hydrochloric acid; from the solution all the iron and cerium are separated by means of sodium acetate and hypochlorite, whilst all the other earths remain in solution.

The precipitate of iron and cerium oxides, mostly of a leather colour, is dissolved in hydrochloric acid; the solution is mixed with an excess of ammonium chloride, well boiled, and completely reduced with sulphurous acid, neutralised with ammonia, and the ferrous oxide thrown down with ammonium sulphide. The filtrate contains the double chloride; it is evaporated to dryness and the residue ignited, when there remains Ce_3O_4, of a lemon colour (atomic weight 92·1). The filtrate, freed from iron and cerium, but containing the remaining earths, is boiled with excess of ammonium chloride to form the double compounds of lanthanum, yttrium, and possibly didymium. Lime is then removed with ammonium carbonate, and the filtrate is boiled with potassa until ammonia is expelled. The precipitate is boiled with oxalic acid, when lanthanium, yttrium, and didymium oxalates are deposited and magnesia dissolves. The oxalic precipitate is ignited, dissolved in sulphuric acid, and forms alums. That of lanthanum and that of didymium, if present, remain on the filter; that of yttrium is found in the filtrate.

If it is desired to recover that part of the glucinum which was extracted with hydrochloric acid and separated along with alumina, the alkaline solution of the two earths is almost neutralised with pure hydrochloric acid, and finally with acetic acid, heated to a boil, and the precipitate after previous purification from silica is extracted with ammonium carbonate.

The questions whether we have here to do with a "neocerium," and what is the composition of the leather-coloured oxide and of the blue substances formerly described, must for the present be left to others whom it may interest.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING SEPTEMBER 30TH, 1887.

By WILLIAM CROOKES, F.R.S.;

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To GENERAL A. DE COURCY SCOTT, R.A., *Water Examiner, Metropolis Water Act*, 1871.

London, October 7th, 1887.

SIR,—We submit herewith the results of our analyses of the 181 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from September 1st to September 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The amount of organic matter in the water supplied to the metropolis during September was exeeedingly small, the results recorded day by day being marked by great uniformity. Thus the organic carbon in the Thames-derived waters was, on an average of numerous samples, 0·125 part per 100,000 parts, the oxygen required to oxidise the oxidisable matters present in the water being about 3-100ths of a grain per gallon. The colour, moreover, of the waters, as shown by the colour meter, was excellent. A few samples of the East London Water Company's supply were recorded as "very slightly turbid." This condition, however, in no respect interfered either with the general purity or with the wholesomeness of the supply. Without exception, the condition of the water supplied to the metropolis during September was entirely satisfactory.

We are, Sir,
Your obedient Servants,

WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

ON PHOTOBROMIDE AND PHOTOIODIDE OF SILVER.

By M. CAREY LEA, Philadelphia.

Photobromide of Silver.

THIS substance is formed, for the most part, by the same reactions as the corresponding chlorine salt.

It is not, however, to be supposed that all reddish-brown substances resulting from the action of reducing agents on silver bromide, are the photo-salt. By reduction AgBr may yield a brownish-coloured form of silver, which, mixed with unreduced AgBr, may form a substance resembling the photo-salt, but having none of its properties. The two are easily distinguished by the action of cold nitric acid, which, added to a brown mixture of AgBr and Ag, quickly dissolves the silver, leaving AgBr. On the photo-salt it has no action.

A beautiful variety of photobromide is easily obtained by dissolving silver nitrate in ammonia and adding it to ferrous sulphate previously mixed with solution of soda. Then KBr is added dissolved in dilute sulphuric acid, until the mixture has a strong acid reaction.

Sometimes this method gives immediately a fine purple, sometimes a brown product. But in either case, after washing and cautiously heating with dilute nitric acid, a beautiful purple results. Much care is needed in the nitric acid treatment, or particles of yellow bromide will form.

A specimen obtained in this way gave figures indicating 7·25 per cent of sub-bromide. Each specimen, however, varies in composition, often very materially.

I subsequently found it desirable in some degree to vary the method, and to determine the best proportions in which the materials were used, to obtain a constant product. That which I prefer to use is as follows:—

Six grms. of silver nitrate are to be dissolved in 200 centimetres cube of water, and ammonia added until the precipitated oxide re-dissolves easily. Twelve grms. of ferrous sulphate are dissolved in 200 c.c. of water, and the silver solution is poured into this. Then four grms. pure caustic soda dissolved in 50 c.c. of water are added, let stand a few minutes, then five grms. of KBr dissolved in a little water. Finally, dilute sulphuric acid until the whole has a strong acid reaction.

This product, well washed and then heated cautiously with nitric acid 1·36 diluted with five times its bulk of water, gives photobromide of a shade of royal purple, extremely beautiful.

Notwithstanding its fine colour it proved to contain but little sub-bromide, not quite one per cent (0·98 p.c.).

Various other methods may be employed. Silver bromide may be dissolved in ammonia and be treated first with ferrous sulphate and then with dilute sulphuric acid. This method, which is very good with the chloride, is less available for the bromide, because of the less solubility of the normal bromide in ammonia, so that although the product is good it is small in quantity.

Very good results are obtained by dissolving silver phosphate, nitrate, and probably almost any other salt of silver in ammonia, adding ferrous sulphate, and after two or three minutes hydrobromic acid.

Potash bromide and cupric sulphate may be made to act on metallic silver in fine powder, but the product is contaminated with much copper, difficult to get rid of.

When AgBr is treated with sodium hypophosphite a brown or brownish-purple form of photobromide is obtained, which seems to be more easily decomposed by nitric acid than most other forms of this substance.

Potash or soda with oxidisable organic substances made to react on silver nitrate and then treated with HBr gives the photobromide. With soda and milk-sugar or aldehyd a rose-coloured or pink product is generally obtained.

Reactions.—In strong solution of potassic iodide it dissolves, and this solution by dilution lets fall pale yellow normal bromide. With a weaker solution it becomes somewhat lighter in colour.

With acid ferric sulphate there is no action in the cold, but with a few minutes boiling the photobromide is converted into bright coloured normal bromide.

In sodium hyposulphite it dissolves, leaving a little black residue of silver.

With ammonia the action at first seems slower than is the case of the corresponding chloride, and if the ammonia is poured over the photobromide in small quantity, it may seem to be without effect. But the photobromide shaken well up in a test-tube with a large excess of ammonia is almost instantly blackened.

Exposed to light, the red shades of photobromide darken with great rapidity. Placed alongside of the corresponding chloride the contrast is very striking:—a strong image forms on the bromide long before anything appears on the chloride; nevertheless, if these two films are thrown into a developing solution, the chloride on which nothing could be seen, gives a vigorous positive development, while the bromide which already showed a strong positive image develops a negative one. The details of this reverse development have been already considered in another paper.

As respects the direct effect of light unaided by development, the contrast between its action on the normal haloids and on the photosalts is very striking. If a rose-coloured photobromide and some normal bromide are exposed side by side, the normal bromide (formed in presence of excess of alkaline bromide) darkens but very slowly, while the photobromide is quickly acted on. I have seen deep purple photobromide change to brown all over its surface with less than five minutes exposure to diffuse light in the middle of a room, an amount of exposure which would scarcely have produced a visible effect on normal bromide formed in presence of excess of KBr.

When photobromide is exposed to the spectrum it shows the same difference in sensitiveness, and darkens more rapidly than photochloride. But it gives little indication of colour.

When exposed under coloured glass photobromide gave distinct indications of reproducing colours, but much less favourably than photochloride. Under green glass it became bluish, under blue greenish, under yellow glass it bleached, and under red glass the red of the photobromide remained unchanged.

Photoiodide of Silver.

The most characteristic colour of this substance seems to be a fine rich purple. It is obtained in much the same way as the corresponding chloride and bromide, with this limitation, that an excess of alkaline haloid must not be present, as the photoiodide is quickly destroyed by it. The iodine salt differs much more from the bromide than does the bromide from the chloride, and two striking distinctions are, its easy decomposition by its own alkaline salt, and its action with ammonia, as will appear beyond.

A very easy and satisfactory method of obtaining the photoiodide is the following:—Silver is to be reduced from the nitrate or chloride in fine powder in any convenient way; I have usually employed Levol's method. To a solution of potash iodine is to be added until the liquid becomes almost black. This iodine solution is to be diluted and poured over the silver by degrees, keeping the silver constantly agitated, until the whole mass becomes clear bright purple.

Any excess of silver present may be removed by boiling with dilute nitric acid, but this operation requires far more circumspection than in the case of the corresponding chlorine and bromine products. The acid (1·36 was used) must be diluted with twelve or fifteen times its bulk of water, and the boiling must be very short, otherwise the photoiodide is converted into normal yellow iodide.

Another method by which it may be obtained is to add ammonia to silver nitrate in considerable excess, and to pour this into solution of ferrous sulphate. Potassic iodide is dissolved in very dilute sulphuric acid and added till the mixture has a sharp acid reaction. It is necessary to observe that the KI added must be somewhat short of a proportion equivalent to that of the silver. Any excess of silver may be removed in the manner already explained.

Different specimens of the purple product in this way obtained gave various amounts of Ag_2I from 0·64 per cent to 4·63. The same remark made as to the meaning of these determinations in reference to the other haloids applies to this.

The method of roasting silver oxide until it is black and acting on it with the hydrogen acid of the halogen, which works well in the case of the chloride, does not answer well for the iodide.

When silver iodide is boiled with solution of sodium hypophosphite it gives a brown product, evidently indicating that reduction to some extent has taken place; the hypophosphite solution may or may not show traces of iodine. The colour of the silver iodide may show a very marked darkening, and yet the solution may give no trace of iodine by the most delicate reagents.

This was very difficult to explain until I found that silver iodide has the property of taking up and retaining small portions of iodine, a reaction not very surprising in view of the tendency I have found in silver haloids to take up foreign substances of very various natures, and also of the facility with which iodine is taken up by alkaline iodides. This property in silver iodide was verified by shaking up portions of freshly-precipitated and still moist AgI with iodine solutions. Alcoholic solution of iodine diluted until it has a pale sherry wine colour is quickly decolourised by AgI, and the same thing happens with a very dilute solution of iodine in KI, which in a few minutes becomes as colourless as water.

This reaction I found particularly interesting, for it not only explained the action of hypophosphite in the case just mentioned, but also gave a clue to the cause of a phenomenon I observed more than twenty years ago, and which then and long afterwards seemed to me an unanswerable argument in favour of the physical nature of the latent image.

At the time referred to I formed films of pure silver iodide entirely isolated from foreign matter by reducing metallic silver on plates of ground glass, iodising them with alcoholic solution of iodine, or with Lugol's solution, then washing most thoroughly under a tap for hours. When these films of silver iodide were exposed to light they received an invisible image which could be developed. But these invisible images, if the plates were laid aside in the dark, had the property of fading out in a few days

or weeks, then could no longer be developed, but the film could receive a fresh image. This seemed an unanswerable proof of the physical nature of the latent image, at least on silver iodide. The argument was:—If the production of this latent image is the result of chemical action involving the loss of iodine by the silver salt, how then is this iodine recovered when the image fades out? It it is formed of subiodide, where does this latter substance get back its iodine to return to the normal form, as it unquestionably does?

No answer could be given then or after, and this experiment, repeated and confirmed by others, has always seemed the strongest support of the physical theory. When, however, it appears that silver iodide can take up iodine and hold it, the course matters follow becomes evident. By the action of light a very small quantity of subiodide is formed, and combines with the normal to form photoiodide. The iodine set free evidently does not pass off, but remains combined with neighbouring molecules of AgI, and in the dark gradually re-combines with the photoiodide, re-converting it to normal AgI. In this retention the lower tension of iodine, as compared with bromine and chlorine, no doubt plays its part.

In thus explaining away the fading out of the latent image on silver iodide, the last argument in favour of the physical theory is destroyed, while the chain of proof supporting this new explanation, that the latent image consists of normal haloid combined with its own sub-salt, remains unbroken.

Reactions. — When ammonia is poured over purple photoiodide of silver, the colour quickly passes to a salmon and then, even after some days, seems to undergo no further change. Of separation of metallic silver, as in the case of the corresponding chloride and bromide, there is no trace.

In sodium hyposulphite it dissolves slowly, leaving a slight but distinct residue.

Dilute nitric acid mixed with dilute solution of KI slowly but completely converts it to normal silver iodide.

Light acts slowly upon it, changing the colour to greenish-grey.

I have already spoken of the remarkable manner in which light acts reversely by development on photobromide. On photoiodide the effect is usually the same as on photochloride, viz., the action is direct. But occasionally it reverses and the exposed part comes out lighter in development than the part that has not been exposed. In this respect the behaviour of the iodine compound is intermediate between that of the chlorine and the bromine.

Note in Conclusion.

The investigations of which the preceding pages are the result, are still unfinished. I have very lately observed the formation of another group of silver haloids quite different from the photo-salts. The members of this new group are deeply coloured, purple or red, not unlike the photo-salts, but are sharply distinguished from them by very different reactions. The photo-salts are unaffected by cold strong nitric acid; these new salts are by very dilute acid instantly converted into a pale pink substance, which appears to be a photo-salt. But the most striking difference is in the action of ferric chloride. A strong solution of this substance shows no action with the photo-salts unless left in contact for many hours or days. But these new haloids are instantly converted by it into what is apparently light pink photo-salt.

So energetic is this action that a solution of ferric chloride containing one part only to a thousand of water quickly attacks these dark purple salts and decolourises them. Such a solution might remain indefinitely in contact with the substances I have called photo-salts without affecting them.

Other differences exist. So far as I have yet been able to observe these new haloids are formed pure, whereas the photo-salts are almost always contaminated with either free silver or free subsalt, or both. As yet there has been no time to fix with exactness their mode of formation or their properties, which I hope to do at a future day.—*American Journal of Science*, June, 1887.

NOTICES OF BOOKS.

A Treatise on the Animal Alkaloids, Cadaveric and Vital; or the Ptomaines and Leucomaines Chemically, Physiologically, and Pathologically considered, in Relation to Scientific Medicine. By A. M. Brown, M.D. With an Introduction by Prof. Armand Gautier, of the Faculté of Medicine of Paris, and Member of the Académie of Medicine. London: Baillière, Tindall, and Cox.

We have here a work which was really needed. Notices of the ptomaines, of their behaviour, and of the means for their recognition, may be found scattered through our medical and toxicological literature; but we find here a systematic view of the whole subject.

Dr. Brown points out the importance of the recognition of the animal alkaloids as overturning one of the fancied distinctions, chemical and physiological, between the animal and the vegetable worlds. He gives a brief history of the discovery of these remarkable substances, and passes on next to explain their origin. The distinction between the ptomaines or cadaveric alkaloids, formed after death, and the leucomaines or vital alkaloids, generated during life, is clearly shown. A body of the former class is said to be "the residual skeleton of the proteine molecule which has undergone continuous disintegrative action, the ultimate terms of which are represented by the pyridic bases."

As methods applicable for extracting these ptomaines from decomposing animal remains, we find described the Stas-Otto process, that of Pouchet, the earlier and the later methods of Gautier, and that of Brieger.

In the section discussing the chemical properties of the ptomaines we find them classified as belonging to two distinct series, the pyridic and the hydropyridic. It is remarked that some of these bases are liquid, volatile, odorous, and contain no oxygen, whilst others are solid, crystalline, and oxygenous. The odour of the liquid ptomaines is said to occasionally remind the observer of musk or of odoriferous plants. Says Dr. Brown:—"It is possible that between the products of the bacterial putrefaction of animal tissues and the perfumes of the vegetable cells of flowers, similarity is not altogether accidental." This remark is suggestive; perfumes are recorded as having been observed as given off from the bodies of persons dying of acute disease, and occasionally the excrements of ruminant animals are found to give off a scent very similar to musk.

The author shows that the reaction by which Selmi, Brouardel, and Boutmy thought the cadaveric bases might always be distinguished from the vegetable alkaloids,—*i.e.*, the reduction of potassium ferricyanide by the former—is not trustworthy. Morphine, atropine, and certain other vegetable bases, instantaneously decompose a mixture of potassium ferricyanide and ferric chloride.

The oxygenous animal bases are described as linking the ptomaines to the leucomaines.

As regards the physiological action of these bodies, it is shown that hydrocollidine is almost as powerful as the venom of the cobra. The medico-legal—it would be surely more correct to say the chemico-legal—bearings of the subject are next taken into consideration. There is no one reagent known which will at once distinguish any and every ptomaine from any and every vegetable alkaloid. But no ptomaine presents all the reactions of any one of the deadly plant bases. Hence Hugounenq holds that it is always possible to distinguish between a vegetable alkaloid introduced into the system during life from a ptomaine developed after death."

But how if the ptomaine has been introduced during life? This is a possible case. Among the methods used

by certain savages of poisoning their daggers, arrows, &c., one is to leave the points in contact with certain putrescent animal matters. It is at least possible that the old Italian poisoners had an empirical knowledge of these bodies, which they seem to have obtained from the carcass of a bear,

The second part of the work treats of alkaloids, generated in the animal system during life, frequently poisonous and yet harmless, because in health they are decomposed or eliminated as fast as produced. We are here introduced to views of the profoundest importance in physiology, and which will bear practical fruit in the medicine of the future.

But whilst we gladly admit the value of this work,—which we have read, we trust not without profit,—we cannot overlook two blemishes; it is disfigured with printing-faults to an unusual extent, and is not written in very good English. Thus we find "trimethylamine" transmuted into "trymethylamine;" the name "Dragendorff" figures as "Drogendorff," "Drugendorff," and twice as "Draggendorff;" "glycocoll" becomes "gylcocolle;" "fibrine" is made into "febrine;" "phosphotungstic acid" is twice given as "phosphotungestic acid" and once as "phosophate-ungestic;" "codeine" is given as "cadine;" "electrode" as "electroid," along with other printer's errors too many to point out.

The author speaks of "naissant" hydrogen instead of nascent. He repeatedly uses the French word "melange" —not italicised—in place of the English "mixture." He speaks of a "cannella" colour instead of "cinnamon" colour." He tells us that a certain alkaloid has been obtained "from the putrefaction of the cephalopode pulps (*sic*) common to the shore of the Mediterranean." "Poulpe" is a name applied in French to certain cuttles, squids, &c., but it is not English either in its original form or when modified into "pulp."

We regret to see a valuable and useful book thus disfigured, and we hope that a second edition when it appears may be freed from the many typographical errors and the Gallicisms which occur in that before us.

Qualitative Chemical Analysis. By Dr. C. Remigius Fresenius, Director of the Chemical Laboratory at Wiesbaden. Tenth Edition. Translated from the Fifteenth German Edition, and Edited by C. E. Groves, F.R.S. London: J. and A. Churchill.

The work of Dr. Fresenius has passed through so many editions, and has earned such general approbation, that to describe its scope and its characteristic features would be utterly superfluous.

The editor informs us, in his Preface, that care has been taken to keep closely to the original text, and there have been none of those attempts at abridgment which marred a former English edition. Additions have been made to that portion of the work which relates to the organic bases and the systematic procedures for their detection. The artificial alkaloids, such as aniline and the animal bases,—ptomaines and leucomaines,—do not come within the plan of the work. It might, perhaps, be thought that the so-called rare earths should have been considered at greater length. But their reactions, and even the elementary character of some among them, are by no means as yet fully ascertained.

The Appendix contains the toxicological methods of Stas, of Dragendorff, Sonnenschein, Graham, and Hofmann, and the dialytic method of separation.

The Index is very copious, and, as far as we have been able to test it, correct.

Any recommendations of a work like this might justly be censured as attempts to "gild refined gold."

Prof. A. E. Foote will lecture on "Gems and Ornamental Stones of the United States," at the Trophy Room, American Exhibition, on Saturday next, October 22nd, at 6 p.m. The chair will be taken by Mr. F. W. Rudler, President of the Geologists' Association.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 13, September 26, 1887.

Distillation of Citric Acid with Glycerin.—Ph. de Clermont and P. Chautard.—The sole product of the reaction is pyruvine.

Velocity of the Oxidation of Solutions of Organic Substances by Potassium Permanganate.—M. Dreyfus.—The author gives his results in the form of a table, the relative velocities of oxidation ranging from 0·20 for saccharose, to pyrogallol, 10000·00.

No. 14, October 3, 1887.

General Results of a New Study of Several Series of Fatty and Aromatic Amines.—M. Malbot.—These new researches lead to a general interpretation of the formation of amines. The final products result from a conflict of energies between the rival affinities of ammonia and the amines for the ether present and for its acid. The growing complication of the amines is the result of a series of successive transformations. The constitution of the amines has been explained on two theories, that of ethylene and that of ethyle, Hofmann preferring the latter, M. Berthelot and the author inclining to the former.

Colours derived from the Aniline Chromates.—S. Grawitz.—The author contends that his aniline black differs from that of Lightfoot and Lauth by containing combined chromium.

General Acidimetric Process for Wines, Musts, Ciders, Beers, &c.—M. Tony-Garcin.—The author uses a normal solution of caustic soda. As it is dropped in the wine turns to a violet-black, more and more dirty, which at last is turned by a single drop to a brown-black without the slightest violet or green tint. This is the exact point of saturation.

Moniteur Scientifique, Quesneville. Series 4, Vol. i., May, 1887.

Some Notes on the Assay of Silks.—Jules Persoz.—In this paper the author discusses the methods proposed for estimating the matter fraudulently added to silks under the name of weighting, loading, or charging. These methods he shows to be deficient in accuracy. H. Sainte Claire-Deville proposed, some years ago, to calculate the proportion of genuine silk present from a determination of the nitrogen, as silk contains 18 per cent of nitrogen, whilst the substances used in its falsification are non-nitrogenous. The author moistens the silk in hydrochloric acid and dries in a stove at 120°. The acid is first diluted with two or three volumes of water, and the sample, after being steeped for a few moments, is exposed to the air before being taken to the stove. It can then be reduced to an impalpable powder, which can be uniformly mixed with the soda-lime. [It is probable that the trade will endeavour, by means which it is not our place to point out, to introduce extraneous nitrogen into the weighted silks—which would of course render this method untrustworthy]. For the detection of tin, which is now introduced even in undyed silks, M. Persoz places in a test-tube a small quantity of the silk in question, and heats it for a few moments with strong hydrochloric acid added in quantity just sufficient to effect a complete solution. The liquid is diluted with water, filtered if turbid, and treated with a current of sulphuretted hydrogen; if tin is present, even in very slight quantities, there is formed a precipitate of the yellow sulphide easily recognised. Tussah silk may easily be distinguished from

mulberry silk by the following reaction:—It does not dissolve in boiling zinc chloride unless this reagent marks at least 60° B., whilst mulberry silk disappears very rapidly in the same reagent at 45° B. In case of a mixture of the two silks, zinc chloride at 45° B. will dissolve the mulberry silk after boiling for a minute, leaving the tussah silk unattacked.

Report on Auramine.—Prof. C. Graebe.—Auramine belongs to the group of colouring-matters prepared latterly by means of tetra-methyl-diamido-benzophenone. This latter body is a product of the reaction of carbon oxychloride upon dimethylaniline (phosgene gas). In 1883 Dr. Kern prepared, for the first time, on a commercial scale, carbon oxychloride, and produced tetra-methyl-diamido-benzophenone, and a colouring-matter known as crystal violet. On a further study of tetra-methyl-diamido-benzophenone, Kern and Caro obtained auramine, a yellow colouring-matter which can be mixed with other basic colouring-matters, capable of being fixed upon cotton by means of tannin.

Action of Hypochlorous Anhydride upon Iodine Trichloride.—H. Basset and Fielding.—From the CHEMICAL NEWS.

Non-acid Components of Bees' Wax.—Fr. Schwalb.—From the CHEMICAL NEWS and *Liebig's Annalen*.

Flame for the Spectrum.—G. Fielding.—From the CHEMICAL NEWS.

Lecture on the Colours of Metals and Alloys.—Prof. W. Chandler Roberts-Austen.—From *Nature*.

New Method of Assaying Quinine Sulphate with Reference to the Alkaloids which Generally Accompany it.—O. Schlickum.—The author finds that not merely quinine but also cinchonine form chromates which at common temperatures require about 2000 parts of water for solution. In a solution of 0·01 grm. quinine or cinchonine sulphate in 20 c.c. of water, potassium chromate does not produce a precipitate. Quinidine and cinchonidine chromates are much more soluble in water. A solution of quinine chromate saturated in the cold is not precipitated by caustic alkalies, quinine hydrate having about the same degree of solubility as quinine chromate. If we, therefore, precipitate a solution of quinine sulphate by potassium chromate, and await the complete crystallisation of the quinine chromate, which requires at least four hours, the filtrate is not rendered turbid on adding caustic soda if the quinine sulphate is pure. On the contrary, if it contains cinchonidine, quinidine, or cinchonine there is formed an opaque flocky turbidity. Cinchonine dissolves only in 4000 parts of water, whilst its chromate dissolves in 2000 parts; consequently caustic soda renders a saturated solution of cinchonine chromate turbid. Chromates of quinidine and cinchonidine dissolve in about 400 parts of water. The bases themselves are much less soluble. The author's method of assay is as follows:—In a test-tube boil 0·5 grm. quinine sulphate with 10 c.c. of distilled water; then add 0·15 grm. of potassium chromate (neutral) in powder. Shake up carefully and set aside for four hours, stirring from time to time, and pour upon a filter. If the quinine sulphate is pure the filtrate will not be rendered turbid either immediately or in the course of an hour by the addition of a drop of caustic lye at 36 to 40° B. If one-half per cent of cinchonine sulphate or one per cent quinidine or cinchonidine sulphate is present the liquid, after the addition of caustic soda. will become turbid in less than an hour.—(*Chemiker Zeitung*, *Pharm. Zeitung*, and *Pharm. Central-Halle*).

Bulletin de la Société Chimique de Paris.
Vol. xlvii., No. 11, June 5, 1887.

(The bulk of the articles in this number have appeared, in substance if not in form, in the *Comptes Rendus*, and have been duly noticed).

Displacement of Ammonia by Magnesia.—Berthelot and André.

Thermic Researches on the Reactions between Ammonia and the Magnesium Salts.—Berthelot.

Contributions to the History of the Decomposition of Amides by Water and Dilute Acids.—Berthelot and André.

The Nitrogenous Principles of Vegetable Soil.—Berthelot and André.

Researches on the Tension of Dry Ammonium Dicarbonate.—Berthelot and André.

Decomposition of Ammonium Dicarbonate by Water, and on the Diffusion of its Components through the Atmosphere.—Berthelot and André.

Researches on the Phosphates.—Berthelot.

On Ammonium-Magnesium Phosphate.—Berthelot.

Combustion and Formation-Heats of Solid Hydrocarbons.—Berthelot and Vieille.

Combustion and Formation-Heats of the Sugars, the Carbohydrates, and Kindred Polyatomic Alcohols.—Berthelot and Vieille.

On Terpinol.—Bouchardat and Voiry.—The authors find that there exists in terpinol an inactive monohydrated terpilene, for which they propose the name of inactive terpilenol or terpol. This inactive terpilenol forms about five-sixths of the entire mass of the terpinol.

Reply to the Remarks of L. Naudin on a Note relating to M. Roussan's Process for the Purification of Phlegmes.—M. l'Abbé Godefroy.—Already noticed.

Reply to M. Kupferschlæger.—F. Weil.—A discussion on Weil's process for the valuation of zinc-powder.

New Process for Preparing Neutral Lead Chromate in Crystals.—L. Bourgeois.—The author boils precipitated lead chromate with nitric acid diluted with five to six volumes of water, decants, and filters the hot solution over glass-wool. It deposits crystals on slowly cooling.

On Glyceric Aldehyd.—E. Grimaux.—This memoir is not adapted for useful abstraction.

Identity of the Cyanaceto-acetic Ether of Mr. W. James with Aceto-cyanacetic Ether.—A. Hallier and A. Held.—The nature of this communication appears sufficiently from the title.

Decomposition of Sodium Sulpharseniate by Silver Nitrate.—Ch. Preis and Bohuslaw Rayman.—Already noticed.

Action of Arsenious Acid upon the Chlorides of Acids.—Bohuslaw Rayman.—In the present paper the author studies the action of benzoyl chloride upon arsenious anhydride at moderate temperatures.

Contributions to the History of Cholesterine.—Bohuslaw Rayman.—The author has not succeeded in preparing either sodium cholesterate nor its ether.

The Chemical Laboratory of Wiesbaden.—The chemical laboratory of Geh. Hofrath Prof. Dr. R. Fresenius, at Wiesbaden, enjoys a very large attendance. In the summer term (1887) there were 77 students on the books. Of these 51 were from Germany, 8 from Austria, 4 from England, 3 from Russia, 3 from North America, 2 from Sweden, 2 from Spain, 1 from Holland, 1 from Belgium, 1 from France, and 1 from Brazil. Besides the Director, Geh. Hofrath Prof. Dr. R. Fresenius, there are engaged, as teachers in the establishment, Prof. Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Dr. E. Hintz, Dr. (Med.) F. Hueppe, and Architect Brahm. The assistants in the instruction laboratory were two in number, in the private laboratory sixteen, and in the Versuchs-station three. Besides the scientific researches, a great number of analyses were undertaken in the different departments of the Laboratory and the Versuchs-station, on behalf of manufacture, trade, mining, agriculture, and hygiene.

THE CHEMICAL NEWS.

Vol. LVI. No. 1457.

THE RELATION OF SCIENCE TO THE STATE.

VI.

We have summarised the principal causes which in Britain prevent capable men from turning their attention to scientific research. We have pointed out that the interference of Government, in as far as it exists, is unfavourable, by establishing and upholding the examinational system of education, with its corollaries, payment by results and cram. On this system the condemnatory utterances of scientific authorities are far more numerous than we have space to enumerate. In addition to the evidence already given we will merely quote the following declaration by Prof. Huxley:—"If it should so happen that a Claude Bernard or a Ludwig should turn up in London among you gentlemen, at the present time, I really do not know what we should do with him; I do not think we could turn him to account. I think we should have to export him to Germany or France."

Such is Prof. Huxley's deliberate opinion as to the uncongenial atmosphere which original research encounters in the United Kingdom!

Another manner in which Government Departments contrive to discourage original research is in filling up scientific appointments. Such posts are but few, and there is the greater urgency that they should be bestowed upon men who have proved themselves competent to enlarge the existing scope of human knowledge in their special departments. But no such necessity is recognised. Judging from official documents such appointments are made by "open competitive examination." In the regulations issued there is neither inducement nor reward for research. We might reasonably expect that, in the selection of professors, demonstrators, curators, &c., original observations, or experimental results might be considered of paramount moment, and if of exceptional value might decide the contest irrespective of all other considerations. But not so; investigations however successful, discoveries however brilliant, count here absolutely for nothing; their very possibility is not taken into account, and their production by any candidate would, we fear, be looked on as something very like contempt of court.

It may not be regarded as beside the question if we quote from one of these official papers: it refers, indeed, to the appointment as Assistant in the Natural History Department of a certain Museum, but in its spirit it may serve as a general specimen. Candidates were first to submit themselves to a "preliminary" scrutiny in handwriting, orthography, arithmetic, English composition, and translation from Latin, French, and German. If satisfactory in all these subjects he proceeds to the main competition. The "obligatory" section of this ordeal comprises, in any case, elementary mathematics (in which 500 marks are obtainable), and any two of the seven following subjects: inorganic chemistry, 500 marks; organic chemistry, 250; physics, 750; zoology (in which the candidate must pass), 500; botany, 500; geology and mineralogy, 500; physiology, 500; and drawing, 500."

This programme is unsatisfactory, in as far as it awards more possible marks for physics than for zoology, which is to be the life-business of the successful candidate.

But, as if on purpose to swamp the meritorious specialist, there is superadded an "optional" department, to which, with inimitable logic, more marks are awarded than to the obligatory. This optional department comprises any of the above seven subjects which the candidate has not selected as obligatory, and in addition any of the following:—"Higher mathematics, 1000 (!!); theoretical mechanics, 500; applied mechanics, 500; French, 500; German, 500; Latin, 400; Greek, 400; and English History, 400."

Under such regulations a biologist "pure, simple," a specialist who has concentrated his attention and devoted his time to the study of the organic world, could stand a very slender chance of success, especially if pitted against a mere smatterer in biology who happened to be well versed in physics, mathematics, and languages. If such regulations are at all a fair average sample of the manner in which public scientific appointments have to be obtained, it is no wonder that we, as a nation, make so poor a figure in original investigation.

Returning to the instance we have just quoted, we may ask how many of the world's greatest naturalists would escape being ignominiously "plucked" in competition with rivals possessing an excellent verbal memory and accustomed to the "cramming" process. Eminent men of Science admit that they would utterly fail if examined on their own published researches against men of such a stamp. How often must the public be reminded that what we want in professors, curators, &c., is not *receptivity*—the only thing which can be fairly tested by any examination—but the power of origination. The question is not what a man knows, but what he can do.

Our present method of requiring irrelevant qualifications not only wastes time, but renders the student liable to acquire habits of thought foreign to his destination. If he has to distinguish nicely between peculiarities of form, of texture, of colour, or odour, he will not be greatly aided by having to turn his attention to words and abstractions.

Not very long ago we felt much pain on finding that, according to a recent ukase, the ranks of surgeon-major and brigade-surgeon are in future to be conferred by examination, not by *rebus gestis*,—*i.e.*, the appeal to past professional success. Here, again, memory will carry the day in opposition to tact, to suggestiveness, and mental resources.

It will, we think, be now plain that by various arrangements Government interferes *against* scientific research. We may entertain doubts as to the policy of the direct patronage of Science by endowments and subventions, and emeritus chairs attached to Universities; but there is surely little room for doubt as to the necessity for a cessation of the hostile interference to which Science and scientific men have been hitherto subject. Our inferiority to Germany cannot be essentially rectified without legislative action; but such action will not, or at least need not, involve heavy demands upon the public purse. How this may be effected we shall endeavour to show in our next issue.

ON SOLUTION.

By SPENCER UMFREVILLE PICKERING.

A short time ago I had occasion to call attention to the danger of attempting to draw conclusions from thermochemical data which are imperfectly understood, as exemplified by a "fundamental law" discovered by Mr. C. A. Seyler, the supposed discovery of which was due to the author having travelled round a circle and arrived at the same point from which he started, without becoming aware of the fact (Chemical News, lv., 227). I have again to call attention to a precisely similar performance which appeared in the Chemical News, (vol. lvi., p. 152). The article is one by Mr. W. Durham "On Solution," being a paper read before Section B of the British Association: in this the author (whose views on solution coincide with my own in many respects), says "that the heat of solution *varies directly*—

(1) As the heat of combination of the positive ele men of the salt with O in water varies.

(2) As the heat of combination of the negative element of the salt with H varies. And *inversely*—

(3) As the heat of combination of the positive and negative elements of the salt varies."

The first example given of this is—

$$\overset{A}{Mg,Cl_2} - \overset{B^*}{Mg,O,Aq} - (\overset{A'}{Ca,Cl_2} - \overset{B'}{Ca,O,Aq}) =$$
$$= \overset{D}{MgCl_2,Aq} - \overset{D'}{CaCl_2,Aq},$$

D and D′ representing the heat of dissolution of the solid chlorides, the other quantities representing the heat of formation of the compounds from their elements in the various states in which they exist at ordinary temperatures. (N.B. *Not* the heat of combination of the constituent atoms, quantities which are unfortunately unknown, and which alone would serve for conclusions such as Durham draws).

Now the value of Mg,O,Aq is derived from the equations—

$$R = Mg,2O,2H,Aq - 2H_2,O$$

and—

$$Mg,2O,2H,Aq = Mg,O,Aq + H_2,O,$$

in which R represents the heat evolved when solid magnesium is dissolved in water.† (See Thomsen, "Thermochem.," iii., 225), whence—

$$Mg,O,Aq = R + H_2,O,$$

similarly Mg,Cl_2, is deduced from the equations—

$$Mg,2O,2H,Aq + 2(Cl,H,Aq) + N = Mg,Cl_2,Aq + 2H_2,O,$$

and—

$$Mg,Cl_2 = Mg,Cl_2,Aq - MgCl_2,Aq,$$

in which N is the heat of neutralisation of the alkali with hydrochloric acid: from these two equations—

$$Mg,Cl_2 = 2(H,Cl,Aq) + R + N + MgCl_2,Aq.$$

Similarly with the calcium compounds: whence Durham's equation becomes—

$$[2(H,Cl,Aq) + \overset{A}{R} + N + MgCl_2,Aq] - [\overset{B}{R + H_2,O}] -$$
$$- [2(H,Cl,Aq] + \overset{A'}{R'} + N' + CaCl_2,Aq] - [\overset{B'}{R' + H_2,O}] =$$
$$= \overset{D}{MgCl_2,Aq}] - \overset{D'}{[CaCl_2,Aq]};$$

and since the heat of neutralisation is independent of the nature of the base, N = N′, and then all the quantities cancel, leaving—

$$MgCl_2,Aq - CaCl_2,Aq = MgCl_2,Aq - CaCl_2,Aq,$$

a result which is not surprising, and which is entirely independent of the magnitude of any of the quantities concerned. Whatever be the value of the heat of dissolution of the salts, or the formation of the salt molecules, his equations must hold good, for the calculation if the latter quantity involves the former.

I have already pointed out that this must be so (*Chem. Soc. Trans.*, 1887, p. 599), and is in reality one of the many consequences of the heat of neutralisation being independent (in ordinary cases) of the nature of the base. Thus another form of expressing Durham's equation would be—

$$\underset{A+D}{Mg,Cl_2,Aq} - \underset{B}{Mg,O,Aq} = \underset{A'+D'}{Ca,Cl_2,Aq} - \underset{B'}{Ca,O,Aq},$$

which would simply be a concrete example of "the general fact that, the heat of neutralisation being independent of the nature of the base, it follows that the heat of formation in solution of the same salt of two different metals differs by a constant quantity independent of the nature of the salt, . . . this difference being simply that existing between the reactions of the two metals with water."

The second equation given by Durham is—

$$Na,Cl - H,Cl,Aq - [Na,Br - H,Br,Aq] =$$
$$= NaCl,Aq - NaBr,Aq,$$

which is still more obviously a truism than his first; for Na,Cl is calculated from—

$$Na,Cl = R + H,Cl,Aq + N + Na,Cl,Aq,$$

and hence by expanding we get—

$$R + H,Cl,Aq + N + NaCl,Aq - H,Cl,Aq - [R + H,Br,Aq +$$
$$+ N + NaBr,Aq - H,Br,Aq] = NaCl,Aq - NaBr,Aq,$$
$$\text{or } O = O.$$

The other instances given are of a precisely similar nature, and need no further comment.

I may perhaps be allowed to add one word of advice, which, if attended to, would save some who are seeking for general laws in thermo-chemistry from pursuing such *ignes fatui*. If the theoretical and experimental numbers agree absolutely, the theory is certainly false; if they agree within 100 cals., the theory is probably false; whereas if the theory is valid, a variable error of several hundred calories will certainly exist. A very slight practical acquaintance with thermo-chemistry would teach that errors of this magnitude must exist in all quantities which are calculated, as in the instances discussed above, from several different experimental results. On the other hand, a certain amount of non-concordance must not be taken as proof that the theoriser is not arguing in a circle, for such non-concordance is often produced by thermochemists (Thomsen in particular) taking different values in calculating various data,—taking average or mean values in one case, and special values in another.

* I fail to see why the heat of formation of the oxides in the presence of water—*i.e.*, *plus* their heats of dissolution—should be compared with that of the chlorides in the *solid* state.

† With magnesium the value of this reaction is really deduced from that observed when the metal is dissolved in hydrochloric acid. Putting it in this form simplifies the equation by rendering it more general without otherwise affecting it. (See Pickering, *Chem. Soc. Trans.*, 1887, p. 600.)

DEEP SEA DREDGINGS: EXAMINATION OF SEA BOTTOMS.

By THOMAS T. P. BRUCE WARREN.

In my previous communication on this subject I omitted to refer to Professor Ehrenberg, of Berlin, who has so thoroughly identified himself with this department of research. I believe Prof. Ehrenberg was one of the first to examine, microscopically, deep sea dredgings, some of which were undertaken for the Atlantic Cable Expedition, 1857.

I propose to deal with the bottoms brought up from Tropical waters of the Atlantic, a few years ago, during certain telegraph cable operations. These soundings were made for survey purposes, and not for any biological or chemical investigation; still I think that this imperfect record may be a useful contribution to chemical science bearing especially on marine operations.

Although there is little to be added to the chemistry of this subject, still I think there are few chemists who could successfully make an analysis of a deep sea "bottom" without some sacrifice of time and patience, to say nothing of the risk of wasting a valuable specimen.

The muds, clays, oozes, &c., from deep water are so very fine that they pass readily through the best kinds of filters, and it is necessary to wash out all traces of sea-water as a preliminary. The specimen must be repeatedly washed by decantation, until the washings are perfectly free from chlorine, when the whole may be thrown unto a filter *merely* to drain; the turbid water which passes through is allowed to stand so that the suspended matter may settle, and, after decanting the clear supernatant water, the residuum is again thrown unto the filter.

The washing and getting ready for the drying oven will, in some cases, require days to carry out, if we wish to avoid losing anything.

So far the proceeding is exactly the same, except

draining on a filter, which would be adopted for preparing for the microscope. On no account should the opportunity be missed of mounting several slides, permanently for microscopic examination. Drawings or photographic enlargements will render us independent of direct microscopic appeal, which is not at all times convenient.

The substance, if drained and allowed to dry on the filter, will adhere most tenaciously to it, so that it is better to complete the drying in a porcelain or platinum capsule, either by swilling the filter with a jet of water or by carefully removing with a spatula. The most strenuous care must he used not to contaminate the specimen with loose fibres from the filter.

The perfectly dried matter is best treated in exactly the same way as a residuum in water analysis. It is a common thing to ignite the residuum, and to put the loss down, if any, to water. This ought not to satisfy an accurate observer, since organic matter, carbonates,—especially in presence of silica,—will easily add to the loss. The best plan is to heat a small portion very cautiously, and note if any smell or alteration in colour, due to carbon, &c., is perceptible, and to proceed accordingly.

I have seen some very satisfactory analyses made on board ship by a skilful use of the blowpipe, where liquid reagents would be very inconvenient to employ.

It will be necessary to say a few words as to the way in which soundings are made at sea. When the bottom consists of sand, mud, or other loose matter, it is easy enough to bring specimens to the surface, and, of course, we know in such a case that the bottom has been reached, but, in the event of the bottom being hard and rocky, it is not easy to say that our sounding has been successful: and here we meet with a difficulty which unfortunately is most unsatisfactorily provided for.

The lead is "cast," as the saying goes, "armed" for this emergency. An iron sinker is made with a hollow recess in the bottom: this is filled in with tallow, and on striking the bottom any loose matter may adhere by being pressed into the tallow. If the bottom is rocky or hard we get simply an imprint in the arming, and when such a result is obtained the usual construction is "that the bottom is rocky" or hard.

Now this seems to me a point on which chemistry may give some very valuable help, for I am convinced that no sounding should be accepted unless evidence of the bottom itself is obtained. A few considerations will show that when we are working in very deep water, where there is a difficulty of knowing for certain that we have an "up and down" sounding, and the hardening of the "arming" by the cold and pressure, unless we bring up something we cannot be sure that we have touched the bottom: leaving the doubt on this point on one side, unless we use a very heavy sinker so as to get an indication of the released strain when it touches the bottom, we encounter another complication.

Sir William Thomson's sounding wire has added the element of reliability to our soundings in this latter case. The note given out by the wire when the bottom is reached is perceptibly different when under strain, even if the dynamometer should give an unreliable indication.

It has been found that when a "bottom" has been recovered by the arming with tallow, the adherent grease seriously detracts from the value of the specimen for scientific purposes. Washing with perfectly pure bisulphide carbon will save the sounding, but of course any living organism is destroyed. As we have plenty of contrivances for bringing up loose "bottoms" without arming, we have nothing to fear on this score.

There is a great difficulty to explain the vast accumulations of clay deposits on the ocean bed, and it has been suggested that some minute organisms may produce these deposits, as others give us carbonate of lime. Is there not a very great probability of some of the apparently insoluble rocky formations being answerable for these accumulations?

We must not forget the peculiar changes which such an apparently stable substance as felspar undergoes when disintegrated and exposed to the chemical action of sea-water. As these deposits contain both sodium and potassium our chemical operations must provide for the analytical result; in other respects the analysis can be proceeded with according to the operator's analytical knowledge.

I have seen some very good specimens of a soft bottom recovered by an ordinary "mushroom" anchor. Between Santa Cruz and Porto Rico we brought up a large quantity of globigerine mud from a depth of 1700 fathoms.

Anyone who has had to work on a rocky or coral bottom knows only too well how reliable an ordinary grapnel is in revealing the contour of the ocean or sea-bed.

Few operators are aware of the usefulness of an ordinary deep sea grapnel-rope, as used for cable work, in recovering specimens of the fauna of any locality. The grapnel-rope should be left down for a few months, so that the denizens of the deep may get used to it and make it their place of residence and *attachment*. The stench caused by their decomposition, unless the rope be kept in water, when hauled up will be in a few days intolerable, even to an individual with a sea-going stomach. I tried several chemical solutions for preserving specimens thus recovered, but nothing answered so well as the water itself drawn up from the same depth as the rope was recovered from.

Some interesting results may be obtained by washing a dredging by ordinary elutriation: in this way I discovered, by the presence of fragments of fresh-water shells, that we were working on the course of the drift from the Surinam River, although we were many miles northward of it. In the same way the drift from the Amazon can be recognised fully 150 miles to the north of that river. This is rather at variance with the course of a current setting out from Florida and striking the Brazilian coast: certainly its influence may not have been felt so near the coast, but an experiment fully confirmed the fact that a strong surface current was running in this direction.

THE METHODS EMPLOYED IN THE ANALYSIS OF IRON ORES.

TOGETHER WITH A

SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID.*

By A. A. BLAIR.

THE treatment of samples of iron ore naturally divides itself into two parts, the mechanical and the chemical, and it will be described under these heads. The care with which the identity of every sample was preserved throughout will be shown, and the methods, by which the determination of the different elements was rendered as accurate as the state of chemical knowledge would allow, will be given in detail.

THE MECHANICAL TREATMENT.

The sample was first taken from the bag and placed upon a large piece of clean strong paper, and the label was removed from the box and put in a little card-rack fixed over the bench. Half a dozen small chips, representing as nearly as possible the different varieties of the ore, were put aside and carefully labelled, to be used for specific gravity determinations, and for thin sections for the microscope.

The large steel mortar, Fig. 1, was half filled with the ore, the leather cover was adjusted, and the machinery

* From "Mining Industries of the United States."

was started. This mortar was cast at the Midvale Steel Works of Philadelphia, and was made of an exceptionally fine quality of propeller steel, containing over 1 per cent of carbon and about fifteen-thousandths of 1 per cent of phosphorus. The pestle was forged and hardened, and the wear, after crushing between 15,000 and 20,000 pounds of ore, was scarcely perceptible in either mortar or pestle. The mortar weighed about 70 pounds, and the pestle with the stem and weight about 25 pounds. The tappets, *a*, were faced with raw hide, which stood the wear of the cams, H, remarkably well, much better than either hard or soft iron or steel, the dust from the ore causing the latter to cut very fast. The shaft made about 90 revolutions per minute, and the ore, when the mortar was about half filled, fed itself, so that without any attention 25 pounds of hard ore in lumps was reduced almost to powder in about one and a half hours.

The stem, B, was hooked up so that the pestle cleared the top of the mortar, A. The pulley, D, raised the mortar clear of the block, and by means of the traveller, E, the mortar was emptied on the chilled iron plate, F, as figured in the sketch. The ore was ground to a fine powder on this chilled plate by the hardened steel muller, C, any of it falling off the plate being caught in the sheet iron troughs,

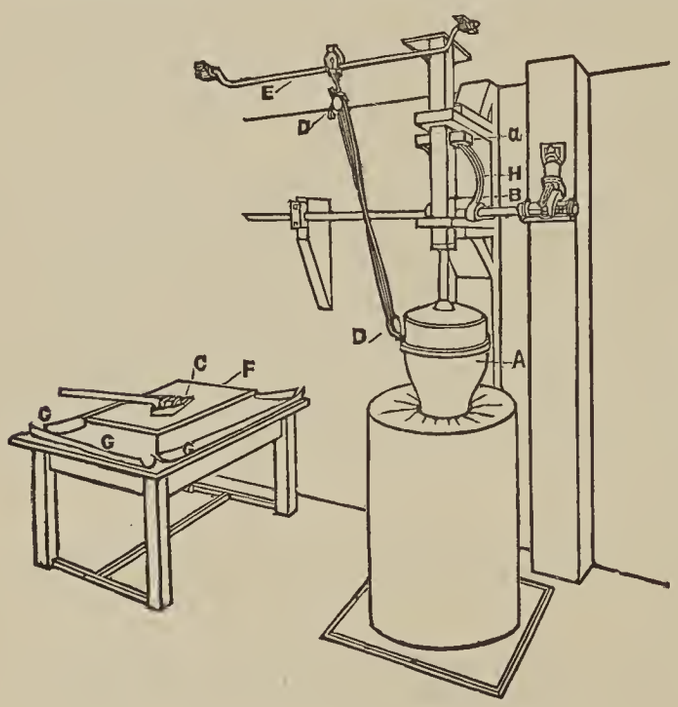


Fig. 1.—Chilled Plate and Steel Mortar.

G. It was thoroughly mixed and quartered, and the resulting sample, reduced finally to about 6 to 8 ounces, was placed in a clean dry bottle. This bottle had the number of the sample etched upon it, the same number, in figures half an inch high, pasted on the neck, and the label which came in the sample bag pasted on its side. The bottle was not taken into the grinding room until the sample was being ground, and was always previously numbered, so that when it was brought upstairs with the label the numbers could be compared and the label pasted on. A portion of the sample was ground in the agate mortar, A (Fig. 2), with an agate pestle, B, fitted in a flexible shaft, C, and revolving at the rate of 700 times a minute, transferred to a ground glass stoppered bottle, and dried at 100° C. It was then ready for analysis.

The Chemical Treatment.

Determination of Phosphoric Acid.

For ores low in phosphoric acid 10 grms. were dissolved in HCl, the solution was evaporated to dryness on the sand-bath, re-dissolved in dilute HCl (one part of acid to two of water), filtered, the filtrate treated with 10 c.c. NH_4HSO_3* to reduce the iron to the ferrous condition, NH_4HO added until the solution was nearly neutral, and then heated until it was decolourised. Five c.c. of strong HCl were added to decompose any excess of NH_4HSO_3, and the SO_2 driven off by passing CO_2 through the boiling solution. When the last trace of SO_2 was driven off, H_2S was passed through the boiling solution to precipitate any arsenic, the sulphide of arsenic filtered off, the beaker placed in cold water, and when thoroughly cooled, dilute NH_4HO added until a slight permanent green precipitate of ferrous hydrate remained after stirring. Acetic acid was added until this precipitate dissolved (a few drops should be sufficient), the solution diluted with hot water to about 800 or 900 c.c., and if the precipitate was white, a dilute solution of ferric chloride or bromine water was added until it became red. If it was necessary to add much ferric chloride, a few drops of ammonic acetate were also added to insure the decomposition of all the former salt. The solution was then heated to boiling, boiled a few minutes, filtered rapidly, and washed once with hot water. The filtrate should pass through the filter perfectly clear, and if the precipitate is red, any subsequent cloudiness of the filtrate is of no consequence. If, however, the filtrate passes the filter cloudy, it should

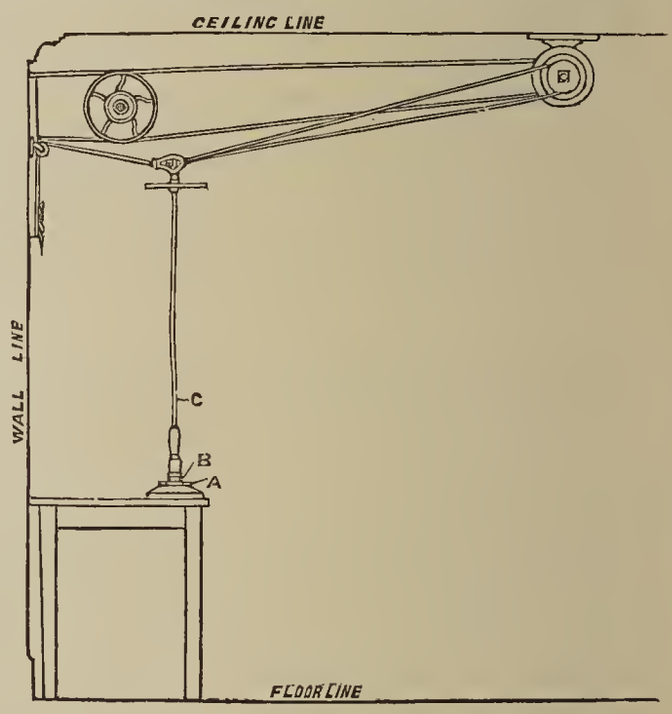


Fig. 2.—Agate Mortar with Flexible Shaft.

be returned to the main portion, a few drops more of ferric chloride added, and the solution again boiled and filtered. The precipitate of ferric phosphate, hydrate, and basic acetate was dissolved in hot dilute HCl (1—1) on the filter, and the large beaker cleared of any adhering precipitate with HCl; the whole solution and washings were received in a small beaker and evaporated nearly to dryness. Five to ten grms. of citric acid were dissolved in the least possible quantity of hot water, and filtered into a small beaker, into which were also filtered about 5 c.c. of magnesium mixture,† and the whole was added to the solution of the ferric phosphate. This solution was then neutralised by NH_4HO and cooled. When perfectly cold, from one-third to one-half its bulk of strong NH_4HO was added, and the solution was stirred

* Made by saturating NH_4HO with SO_2, generated by heating powdered charcoal and strong H_2SO_4 in a flask. The mixture was made of the consistency of cream, and the gas passed first through a wash-bottle containing water.

† Made by dissolving equal weights of $MgCl_2$ and NH_4Cl in the least possible quantity of water, filtering, adding $\frac{1}{8}$ bulk of NH_4HO_s, stirring occasionally and allowing it to stand for some days before using.

until the precipitate of $Mg_2(NH_4)_2P_2O_8$ began to form. After standing for some time, the solution was stirred again, and the stirring was repeated at intervals for an hour. It was allowed to settle over night, filtered on the asbestos felt in Dr. Gooch's pierced crucible, washed with dilute NH_4HO (1—3), dried on the pump, moistened with a drop or two of NH_4NO_3 in ammonia, dried and ignited until the glow passed over the precipitate, cooled in a desiccator and weighed as $Mg_2P_2O_7$. This precipitate was then dissolved in dilute hot HCl, the felt was washed on the pump, and the crucible was heated to redness and re-weighed. This weight, unless the precipitate of $Mg_2P_2O_7$ contained SiO_2, agreed perfectly with the original weight. In the latter case, however, the last weight of the crucible was subtracted from the weight of the crucible with the precipitate, to obtain the weight of $Mg_2P_2O_7$. The table A was used for calculating the percentage of P_2O_5, or P, instead of the factors 0·6396 or 0·2793.

Table for Phosphorus and Phosphoric Acid.

Mg.	P.	P_2O_5.	Mg.	P.	P_2O_5.
1	0·003	0·006	51	0·142	0·326
2	0·005	0·013	52	0·145	0·332
3	0·008	0·019	53	0·148	0·339
4	0·011	0·026	54	0·151	0·345
5	0·014	0·032	55	0·154	0·352
6	0·017	0·038	56	0·156	0·358
7	0·019	0·045	57	0·159	0·264
8	0·022	0·051	58	0·162	0·371
9	0·025	0·057	59	0·165	0·377
10	0·028	0·064	60	0.167	0·384
11	0·031	0·070	61	0·170	0·390
12	0·033	0·077	62	0·173	0·396
13	0·036	0·083	63	0·176	0·403
14	0·039	0·089	64	0·179	0·409
15	0·042	0·096	65	0·181	0·416
16	0·045	0·102	66	0·184	0·422
17	0·047	0·108	67	0·187	0·428
18	0·050	0·115	68	0·190	0·434
19	0·053	0·121	69	0·193	0·441
20	0·056	0·128	70	0·195	0·448
21	0·059	0·134	71	0·198	0·454
22	0·061	0·141	72	0·201	0·460
23	0·064	0·147	73	0·204	0·467
24	0·067	0·153	74	0·207	0·473
25	0·070	0·159	75	0·209	0·479
26	0·073	0·166	76	0·212	0·486
27	0·075	0·173	77	0·215	0·492
28	0·078	0·179	78	0·218	0·499
29	0·081	0·185	79	0·221	0·505
30	0·084	0·192	80	0·223	0·512
31	0·086	0·198	81	0·226	0·518
32	0·089	0·204	82	0·229	0·524
33	0·092	0·211	83	0·232	0·531
34	0·095	0·217	84	0·235	0·537
35	0·098	0·224	85	0·237	0·544
36	0·100	0·230	86	0·240	0·550
37	0·103	0·237	87	0·243	0·556
38	0·106	0·243	88	0·246	0·563
39	0·109	0·249	89	0·248	0·569
40	0·112	0·256	90	0·251	0·576
41	0·114	0·262	91	0·254	0·582
42	0·117	0·269	92	0·257	0·588
43	0·120	0·275	93	0·259	0·595
44	0·123	0·281	94	0·262	0·601
45	0·126	0·287	95	0·265	0·607
46	0·128	0·294	96	0·268	0·614
47	0·131	0·300	97	0·271	0·620
48	0·134	0 307	98	0·274	0·627
49	0·137	0·313	99	0·276	0·633
50	0·139	0·319	100	0·279	0·639

When the amount of $Mg_2(NH_4)_2P_2O_8$ was large it was dissolved, boiled, and re-precipitated, as a small amount of MgO was liable to be carried down mechanically with it. It was found necessary to avoid heating the $Mg_2P_2O_7$ after the glow had passed, as this salt is liable to attack the asbestos slightly at high temperatures, causing a small loss in weight of the felt on the subsequent solution of the precipitate in dilute HCl. For ores containing TiO_2 it was necessary to modify this process in several particulars. It was found that under certain circumstances phosphoric acid combined with TiO_2, forming a salt (possibly a phospho-titanate) very insoluble in HCl, so that in almost every instance phosphoric acid was found in the insoluble siliceous residue when this contained titanic acid. Also, upon neutralising the main solution, after adding NH_4HSO_3 in ores containing TiO_2, a fine white precipitate resembling $BaSO_4$ was formed, which usually remained after the subsequent addition of HCl, and was found to consist of TiO_2 with some P_2O_5. If, after dissolving the precipitate of ferric phosphate, &c.,

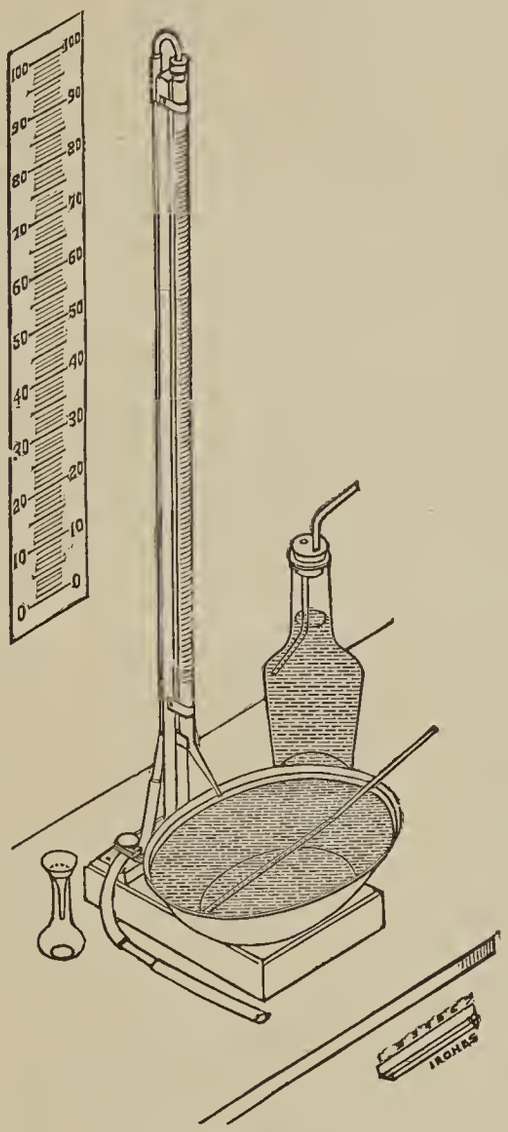


Fig. 3.—Burette.

thrown down by ammonic acetate, the solution was allowed to run to dryness, there was found after re-solution in HCl, a granular white or yellowish residue, absolutely insoluble in HCl, which consisted essentially of TiO_2 and P_2O_5. This reaction affords a very delicate test for TiO_2, for if the residue obtained in this latter case be collected on a small filter, dried, ignited, and fused with Na_2CO_3 and the fusion treated with hot water, a residue of $NaTiO_3$ will remain, which is insoluble in water. This residue, collected on a small filter, dissolved in a little hot dilute HCl and treated with Zn in a test-tube, gives the very characteristic violet colour due to Ti_2O_3.

When TiO_2 was found it was necessary to fuse the insoluble siliceous residue, the residue left in the filter from the solution of the precipitate by ammonic acetate,

and the residue left from the re-solution of this latter after it had run to dryness with Na_2CO_3. The fused mass was treated with hot water and filtered; the filtrate containing, besides silica and alumina and sodic carbonate, all the P_2O_5, while the TiO_2 remained on the filter as sodic titanate, insoluble in water. Potassium salts should not be used, as potassic titanate is decomposed by water. The filtrate was acidulated with HCl evaporated to dryness, dissolved in water with a little HCl, filtered, a few drops of solution of Fe_2Cl_6 added, and the ferric phosphate precipitated by ammonic acetate. This precipitate was filtered, washed, dissolved in HCl, and the P_2O_5 was determined by magnesium mixture as usual.

Sulphur and Iron.

One grm. of ore was fused with 10—12 grms. of Na_2CO_3 and a little KNO_3, the fused mass was run well up on the sides of the crucible, and the crucible was chilled. The mass was then detached from the crucible and transferred to a tall beaker, or the crucible with its contents was placed in the beaker and treated with boiling water. When the fused mass was entirely disintegrated (the crucible, if placed in the beaker, having been washed off and removed) the ferric oxide was allowed to settle. If the solution was coloured by alkaline manganate a few drops of alcohol were added and the solution was allowed to stand until the colour disappeared. If the solution after the disappearance of the colour due to the manganate was yellow, it was an indication of the presence of Cr_2O_3 in the ore. It was then decanted through a filter and washed twice with hot water by decantation.

The filter was washed once or twice with hot water, and the filtrate was acidulated with HCl evaporated to dryness, re-dissolved in hot water with a few drops of HCl, filtered from the SiO_2 and the sulphuric acid precipitated by $BaCl_2$ in the boiling filtrate. After standing over night in a warm place the $BaSO_3$ was filtered on the felt, washed thoroughly with hot water (and ammonic acetate, if it was large), and weighed as $BaSO_4$, which, multiplied by 0·1373, gave the S.

The crucible in which the fusion was made was treated with HCl, and when the adhering Fe_2O_3 was dissolved, a little hot water was added, and the whole was poured on the filter to dissolve any Fe_2O_3 which might have been in suspension in the solution of the fused mass. This was allowed to run into the beaker containing the Fe_2O_3, the crucible was rinsed, and the filter was washed with hot water. The whole was evaporated to dryness to render SiO_2 insoluble, re-dissolved in HCl, and transferred to a small flask of about 50 c.c. capacity. A small funnel was put in the neck of the flask and 3 grms. of granulated zinc in small lumps were added carefully to the solution. By heating the solution and adding a few drops of HCl from time to time, the ferric chloride was soon reduced to ferrous, which was shown by the solution becoming colourless. After washing down the neck of the flask and the funnel with a fine jet of water, if the addition of a few drops of HCl failed to impart any colour to the solution, the reduction was considered complete. Fifteen c.c. of dilute H_2SO_4 (1—1) were added, little by little, to the solution, and when the zinc had all dissolved, the neck of the flask and the funnel were carefully washed down and the flask was filled nearly to the top with hot water. The flask was then placed in cold water, and when the solution was thoroughly cooled it was washed out into an oblong white dish of about 1500 c.c. capacity and diluted to about one litre. A solution of permanganate of potassa was run in from a burette, the representation of which is given in Fig. 3.

This form of burette, the invention of Mr. Thomas H. Garrett, is the most satisfactory one I have ever used. The solution of permanganate was carefully standardised by means of ferric chloride of known strength, made by dissolving wrought-iron of known composition in HNO_3, driving off the nitric acid by repeated evaporations with HCl, diluting, filtering into a clean glass-stoppered bottle, and determining the Fe_2O_3 gravimetrically in a weighed amount of the solution. The strength of the ferric chloride solution being thus accurately known, a portion was weighed out into one of the little flasks previously mentioned, reduced with zinc, sulphuric acid added, and the strength of the permanganate solution determined by titration. The amount of the solution necessary to colour 3 grms. of zinc treated with HCl and H_2SO_4, and diluted to the same volume as the solution of the ore, was subtracted before calculating the value of the permanganate solution, and also from the amount of permanganate solution required for the ore before calculating the percentage of iron. By using H_2SO_4 in addition to the HCl, as described above, it was found that the end reaction with potassic permanganate was as sharp as if no HCl was used, and the results obtained were in all cases as accurate as could be desired. For many ores it was possible to dissolve the finely ground sample directly in the flask in HCl without previous fusion, but for those containing ferrous silicates, or pyrites, it was generally necessary to resort to fusion for the accurate determination of the total Fe.

(To be continued).

ON REMARKABLE RELATIONS BETWEEN THE SPECTRUM OF WATERY VAPOUR AND THE LINE SPECTRA OF HYDROGEN AND OXYGEN,

AND ON THE

CHEMICAL STRUCTURE OF THE TWO LATTER BODIES AND THEIR DISSOCIATION IN THE ATMOSPHERE OF THE SUN.

By Professor A. GRUENWALD.

DURING a mathematical investigation of the changes which the properties, and especially the spectra, of two gases undergo on their chemical union to a new substance, the author succeeded in finding a simple and important proposition of a future chemico-mathematical theory of perturbations, and by its means of discovering very remarkable relations between the spectra of hydrogen and oxygen on the one hand and of watery vapour on the other, as well as the chemically compound nature and the structure of hydrogen and oxygen, and in demonstrating the dissociation of hydrogen in the atmosphere of the sun.

I.

The above-named fundamental theorem is :—

"Let a be a primary chemical element which is combined chemically with other elements in a gaseous substance, A, and which in a unit volume of A occupies the volume $[a]$. Let A combine chemically with another gaseous body, B, to form a third, C. During this combination the element, a, passes into another chemical condition, a', giving off a certain quantity of heat (or otherwise taking it up) to render the new combination possible, and becoming, in consequence, chemically condensed (or expanded). Let the volume which it occupies in C, after the establishment of the new movable chemical equilibrium, be $[a']$, whereby the quotient $[a']:[a]$, according to a well-known fundamental chemical law, is a rational number, generally very simple. This being premised, the wave-lengths, λ, of all the rays belonging to the element, a, in the line-spectrum of the free substance, A (and are therefore emitted by it) are to the wave-lengths λ' of the corresponding rays, which the same element emits in its new chemical condition, a' (in which it exists in the now combined substance, A, within the newly formed combination, C), as the corresponding volumes $[a]$ and $[a']$."

This theorem holds good only when the substances in question are gases tolerably remote from the critical point of liquefaction, and existing not under too high a pressure. The modifications which it undergoes when

these conditions do not hold good, as well as the simple and natural fundamental suppositions upon which the proof rests, cannot be communicated except in an extensive treatise.

From the above theorem it follows especially that when $[a']=[a]$, *i.e.*, when the volume of the element, *a*, in the new compound, C, is the same as in the original, A, the wave-lengths, λ', of the rays emitted by *a'* are equal to the wave-lengths, λ, formerly given out by *a*. The only difference will be in the different modification of the amplitudes, and therefore of the intensities of the single rays, when it may happen that the brightness of one entire series of rays may be enfeebled to vanishing, whilst that of another may be intensified. Thus, *e.g.*, the spectra of compounds formed without chemical condensation, such as of H with Cl, Br, and I, consist only of the spectra of H, on the one hand, and of Cl, Br, or I on the other, but with characteristic modifications of the intensity of the different rays of their components.

The limitation to the gaseous condition is necessary, since, as it is generally the case in chemistry, simple, regular, and easily intelligible regulations exist for gasiform bodies only. If the pressure increases, or if the gaseous substances approximate to liquefaction (whether by a reduction of temperature or a simultaneous increase of pressure) the number of collisions between two different molecules under otherwise equal conditions will be correspondingly increased, and the numbers of vibrations of the smallest equivalent particles of the different homogeneous molecules of the same substance are changed in different manners by different collisions. Whilst in the former case corresponding equivalent particles of different homogeneous molecules of the same substance emit extremely faint rays of equal wave-length which coincide in the spectrum, and by the summation of their individually very minute intensities, yield a single ray of perceptible brightness, in the case just mentioned the equivalent particle of different homogeneous molecules emit, along with rays of normal periods, also rays of more or less divergent periods, which owe their origin to heterogeneous collisions. Along with the normal line there fall now closely adjacent rays of the latter kind. The originally sharp line widens. If the pressure increases and if the gases approach liquefaction the widening of the line in question increases, and it may happen that the band produced extends into the region of lines which correspond to heterogeneous particles of the different molecules of the same substance. The lines of the spectrum flow together, and there is formed a more or less continuous spectrum, in which, perhaps, single luminous maxima betray the position of the former normal main rays.

II.

The most important of the remarkable relations between the line spectra of H, O, and of H_2O (in vapour) are :—

1. "All the wave-lengths of the second or so-called composite line spectrum of hydrogen, which have been determined in so excellent a manner by Dr. B. Hasselberg, of Pulkowa, and which owe their origin to a more complex structure of the H molecule, H', can, after elimination of the rays belonging to the elementary line spectrum, be converted into corresponding wave-lengths of the spectrum of water by multiplication with the factor $\frac{1}{4}$."

This proposition, which was first found out empirically (for a great number of rays) by comparing the second spectrum of hydrogen with the spectrum of water, as then known and then recognised as universally valid by means of the theorem (I.), is, according to I., a simple result of the circumstance that the modified hydrogen molecule, H', occupies in watery vapour exactly half its volume in the free condition. The knowledge of this put the author in possession of a great number of wave-lengths of the water spectrum hitherto unknown, *i.e.*, those which hydrogen produces under the influence of the oxygen in watery vapour. He was thus able, on May 9, 1887, to submit to Prof. G. D. Liveing, of Cambridge, an extensive list of wave-lengths of the water spectrum, hitherto unknown, for an experimental test of the accuracy of his chemico-mathematical theory of perturbation. These predictions, as it may be seen from the following list, have been very satisfactorily confirmed as far as Prof. Liveing's observations have hitherto extended, and especially for the rays $\lambda=2800$ to 2607·8 and for $\lambda=2603$ to 2449.

According to Prof. Liveing's letter of June 19 :—

Foretold.	Observed.	Foretold.	Observed.
2800·5	2799·8	2792·5	2793·8
2798·5	2797·6	2768·5	2768·3
2759	2759·7	2677·5	2677·3
2753	2753·1	2672	2671·1
2749	2748·2	2667·5	2668·2
2742	2742·7		2666·0
2731·5	2732·1	2660	2659·6
	2730·5	2652	2651·3
2718·5	2718·2	2646·5	2645·6
	2717·2	2642·5	2642·2
2713·5	2713·6		2640·4
2710	2709·5	2637·5	2638·5
2705·5	2706·2		2636·8
	2705·2	2633	2633·3
2699·5	2701·5	2629·5	2631·1
	2699·7	2623·5	2624·1
2693·5	2693·7		2623·3
	2693·2	2615·5	2614·9
2687	2687·6	2612	2611
	2687·2	2607·5	2608·3
2682·5	2683·5		
	2683·0		

According to letter June 26 :—

2603	2603·2	2516	2517·6
2599	2598·6		2515·1
2595·5	2596·4	2508·5	2509
2591	2591·3		2508
2585	2584·4	2491	2491·1
2578·5	2578·3	2487·5	2487·2
2572·5	2573·4	2484	2484·9
2564·5	2565·4		2483·7
2556	2556·4	2479	2479·3
2542	2542·7	2473·5	2474·5
2535	2536·6	2467·5	2467·1
	2534·1	2464·5	2464·5
2532·5	2531·4	2460·5	2460·0
2528	2529·2	2454·5	2454·7
2525	2524·2	2449	2449·3
2520·5	2521·7		
	2519·8		

The further rays which the author predicted on May 9, *i.e.*, from $\lambda=2449$ down to $\lambda=2207$ have not yet been determined with certainty owing to their extreme faintness. Below $\lambda=2200$ Professors Liveing and Dewar have not yet succeeded in discovering any lines of the H_2O spectrum. Nevertheless, according to his theory, there must be a more refrangible section of the water spectrum of excessive faintness. The wave-lengths of this section must correspond with the wave-lengths of hydrogen, as laid down by Dr. B. Hasselberg in an appendix to his researches on the hydrogen spectrum, in 1884.

The wave-lengths of the relatively somewhat brighter rays of this section of the water spectrum are :—2248·7 ; 2244·8 ; 2230·1 ; 2223·5 ; 2205·8 ; 2173·5 ; 2169·4 ; 2111·0 : 2110·8 ; 2105·9 ; 2102·2 ; 2099·6 ; 2097·5 ; 2090·8 ; 2089·7 ; 2088·2 ; 2087·2 ; 2085·3 ; 2078·0 ; 2038·7 ; 2034·6 ; 2033·2 ; 2031·0.

The experimental verification of this forecast can succeed only with a very peculiar arrangement of the procedures. Possibly the application of several sparks (or arcs) passing in series through moist gases, or through a broad stream of watery vapour, or better still of several hydrogen flames, similarly arranged in oxygen, and the observation of the rays emitted in the direction of their line of junction, might lead to the result desired. The rays

emanating from the more remote sparks or arcs would intensify the vibrations produced nearer at hand and taken up by the telescope. The author further proposes, according to the suggestion of his colleague, Prof. Zenger, to immerse the photographic plates before use in an extremely concentrated solution of chlorophyll, and then to dry them.

2. The wave-lengths of the elementary line spectrum of hydrogen may be divided into two groups (*a*) and (*b*), in such a manner that the wave-lengths of the one group (*a*) multiplied by the factor 0·6336 (very nearly 19-30ths) and those of the other group (*b*) multiplied by 4-5ths are converted into corresponding wave-lengths of the H_2O spectrum."

Hence it follows, with the aid of theorem (I.) that hydrogen consists of two primary elements, *a* and *b*, one of which, *a*, produces the group (*a*) under the influence of *b*, whilst the other, *b*, produces the group (*b*) under the influence of *a*. If (*a*) and (*b*) are respectively the volumes which the substances *a* and *b* occupy in a unit volume of hydrogen, then :— $[a]+[b]=1$, and according to (I.) $\frac{19}{30}[a]+\frac{4}{5}[b]=\frac{2}{3}$; *i.e.*, $[a]:[b]=4:1$, $[a]=\frac{4}{5}[b]=\frac{1}{5}$.

Hence hydrogen is a compound of one volume of the primary substance, *b*, with four volumes of the other primary substance, *a* : H : *b a* 4 ; it is, therefore, a compound analogous to ammonium NH_4, the volume of which, on its dissociation at a sufficiently elevated temperature, is in the proportion of 2 : 3.

The substance *a* is the lightest of all gaseous bodies, much lighter than hydrogen, and *b*, if we regard *a* as a univalent element, is a pentavalent gaseous element similar to nitrogen.

The line-spectra of the primary substances, *a* and *b*, can now, according to (I.), be easily calculated from the corresponding groups, (*a*) and (*b*), by multiplication with the factor $\frac{3}{2}$. Hereby, unfortunately, the errors in the wave-lengths of these groups increase in the same proportions. The star-spectra given by W. Huggins in *Phil. Trans.* (1880, vol. 171, Part II., p. 669 to 690), especially those of α Aquilæ and Arcturus, whose most refrangible rays are hydrogen rays, and according to 2 can be determined and corrected as hydrogen rays by comparison with the H_2O spectrum and with the solar spectrum, admit of a very fruitful completion of the H spectrum in its ultra-violet portion as at present known, and permit us to draw up a very copious spectrum of the primary element, *b*, The author prodeeds to give the spectra of the elements *a* and *b* of hydrogen, and places opposite to their lines. for comparison, the nearest lines of Frauenhofer and of the chromosphere.

The wave-lengths of the Frauenhofer lines were taken directly from a good copy of Angström's Atlas ; those of the chromosphere were obtained from Young's second list. The author reserves the right of resuming the calculations and comparisons as soon as he has access to Thollon's "Noveau dessin du spectre solaire," Piazzi Smyth's "Visual Solar Spectrum in 1884," and especially A. Rowland's "Photographic Map of the Solar Spectrum."

(To be continued).

CORRESPONDENCE.

EXAMINATION OF OILS.

To the Editor of the Chemical News.

Sir,—I observe in Chemical News, vol. lvi., p. 168, a letter from Mr. Thomas T. P. Bruce Warren, written in reply to that of mine published in the Chemical News, vol. lvi., p. 149.

Mr. Warren having asserted that "with a few trifling exceptions, all that appears from time to time in our chemical journals may be found in Chateau's *Corps Gras Industriels* (1864) and Fontenelle's *Manuel d'Huiles* (1866)," I gave a list of ten quantitative methods of examining oils, all or nearly all of which had "been devised or perfected within the last twenty years, and the majority of them within the last eight or ten, and hence could not have been described, or even foreshadowed, in books published in 1864 and 1866."

Mr. Warren now admits that he has "no practical acquaintance" with five of these general methods, viz. :— (1) Hausemann's method of titrating free fatty acids with the aid of phenolphthalein ; (3) Hehner's method of examining butter; (4) Reichert's method of determining volatile fatty acids ; (5) Gladding's process of separating fatty and resin acids ; (7) the improved methods of determining specific gravity devised by Bell, Estcourt, &c. Mr. Warren excepts, however, "a different reaction for the presence of free acids, and "the specific gravities of substances likely to contain air." But it is not a reaction for *detecting* free fatty acids, which was devised by Hausemann, but a process for determining their amount with the same facility and accuracy as a mineral acid admits of. If Mr. Warren has a still better method of effecting this, chemists will be glad to be informed of it. Similarly the improved methods of determining specific gravities of fats were not devised with the object of eliminating errors due to air-bubbles (though they may serve that purpose among others), and the reference made by Mr. Warren to this point suggests that he is not acquainted with their real object or character.

There remain five quantitative general methods of examining oils which Mr. Warren still maintains are contained or foreshadowed in Fontenelle's work, published in 1866. Fontenelle's work is not contained in the library of the Chemical Society, or any other to which I have access, and hence I am unable to refer to the pages quoted by Mr. Warren, and am under the necessity of asking him to quote the actual passages he relies on to prove his case.

Thus he contends that (2) Koettstorfer's method of ascertaining the saponification-equivalents of oils is "foreshadowed" on p. 19 of Fontenelle's work. But is any process of the kind described in a reasonably practicable form, and are figures given showing the behaviour of oils of different kinds when examined by the method ? If not, is it fair to assert that Koettstorfer's invaluable method was already known ?

Again, with respect to the method of determining the iodine-absorptions of oils recently devised by Baron Hübl, Mr. Warren states that the use of iodine is described in Chateau's work, published in 1864. Now, I challenge Mr. Warren to quote the passage on which he relies in support of this statement, and to quote the iodine absorptions given by Chateau for any six oils. It is evident that the *qualitative* use of iodine as a reagent for certain essential oils is quite another matter to its quantitative use for examining fixed oils in the manner devised by Hübl, and if Mr. Warren cannot adduce the evidence I demand, it is unfair to credit Chateau's work with a description of a method of determining the iodine-absorptions of oils.

As to Maumené's method with sulphuric acid, I simply claimed as new "the many quantitative determinations" made by his process, the publication of which Mr. Warren thinks unworthy of acknowledgment. If Mr. Warren would follow the example of other chemists, and publish the quantitative results he has obtained by his methods of determining free fatty acids and specific gravities, and the method of separating fatty substances from resins and rosin oils, described on page 415 of Fontenelle's book, he will earn the gratitude of many chemists who, like myself, were under the impression that the separation of fatty or resin acids was a difficult problem, which had only been solved comparatively recently ; and who have also believed that resin and rosin oils were essentially different in their chemical nature, and could not be ex-

pected to behave analytically in the same manner. It has been said, I think in these pages, that nothing finds its proper level sooner than an analytical process. If this be true, it is curious that so many valuable methods as appear to be described in Fontenelle's book should not have found their way into more modern compilations.

Mr. Warren thinks the chemists who have devised improved methods of determining glycerin (9) deserve no recognition of their labours, since "the claim raised here ignores what we owe to Chevreul . . . . who indicated that the amount of glycerin from the same oil should be constant." I challenge Mr. Warren to show that Chevreul indicated any such thing; but if he did, is that any reason why Mr. Warren should deny any value to the more recently devised methods of *determining* glycerin? Mr. Warren seems to confuse the discovery of a chemical fact with the invention of an analytical process.

Mr. Warren states that he is "certainly not acquainted with a satisfactory mode of procedure" for determining "the higher alcohols in sperm and bottle-nose oils," and of hydrocarbon oils in fatty oils generally. Why then does he not publish figures showing the faulty nature of the methods on which chemists are accustomed to rely? But perhaps he has "no practical acquaintance" with these processes, any more than he has with Koettstorfer's, Reichert's, Hehner's, Gladding's, or Bell's methods. Until, however, he can claim this he is scarcely in a position to state that with a few trifling exceptions all of value about oils may be found in the antiquated works of Chateau and Fontenelle, or to state that we can hardly congratulate ourselves when we consider how little has been done during the last twenty years to render our knowledge of this very important subject more complete and trustworthy.—I am, &c.,

ALFRED H. ALLEN.

Sheffield, October 17, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 15, October 10, 1887.

Graduation of Tubes for Use in Gas-Analysis.—M. Berthelot.— The author fills the tube with mercury when in an upright position, the closed end being downwards, until it overflows, taking care that no air-bubble is interposed. A small flat piece of glass, rather thick, is pressed down upon the open end of the tube, which is then inverted. The whole — tube, mercury, and glass plate—is then weighed on a balance sensitive to 1 c.g. or beyond. When this is done the arrangement is taken out and placed above a small capsule, and one corner of the glass plate is raised slightly so as to permit a certain quantity of air to enter and a corresponding quantity of mercury to escape. The contact of the plate and the tube is re-established, the arrangement is laid on a large horizontal plane, and the graduation corresponding to a horizontal plane tangential to the surface of the meniscus is read off with a lens. He then weighs, as may be most convenient, either the mercury which has escaped into the capsule or the entire system formed by the tube, the mercury, and the plate which gives the weight of the mercury escaped by difference. This weight, divided by the exact density of mercury at the temperature of the experiment, furnishes with great precision the volume of the interior space now occupied by air and limited by the graduation. In this manner the graduation of any tube may be verified and a table of correction drawn up.

Action of Carbonic Acid upon Certain Alkaloids.—A. Ditte.—The author has obtained carbonates of some organic bases by placing in the tube of Cailletet's apparatus dry carbonic acid and a few drops of a liquid base. Crystalline compounds have thus been obtained of carbonic acid with aniline orthotoluidine and α-metaxylidine. The pyridic bases do not enter into combination with carbonic acid under these conditions.

A New Source of Capric Acid.—A. and P. Buisine. The authors use as a source suint waters, *i.e.*, water from washing wool, when it is about eight days old. They add to it a small excess of sulphuric acid and heat slightly so that the fatty matter may collect together. This is then washed repeatedly with cold water, purified by solution in ether, and the solution is filtered and distilled. From the crude fatty matter thus obtained pure caprie acid is extracted by a very circumstantial process.

The Direct Saccharification by Acids of the Starch contained in Vegetable Cellules. Extraction of the Glucose formed by Diffusion.—MM. Bondonneau and Foret.—The nature of this memoir appears sufficiently from its title.

Moniteur Scientifique, Quesneville. Series 4, Vol. i., June, 1887.

Loss of Nitrogen by Plants during Germination and Growth.—W. O. Attwater and E. W. Rockwood.—From the *American Chemical Journal.*

Absorption of Atmospheric Nitrogen by Plants.—W. O. Attwater.—From the *American Chemical Journal.*

Valenta Method for the Assay of Oils. — George Hurst.— From the *Journal of the Society of Chemical Industry.*

Synthetic Formation of Closed Carbon Chains.—Dr. W. H. Perkin, Jun.—From the *Journal of the Chemical Society.*

Contribution to the Study of Rotatory Polarisation in Parallel Light.—Dr. G. Quesneville.—It results from this memoir that, independently of the complementary colours observed in the ordinary and extraordinary images of the analyser, there exists white light which accompanies, and may even mask, the colour of the images. In thin quartz plates the inequality of intensity of the two images being very great, the excess of the luminous intensity of one of these images over the other is due to white light. The intensity of the colouration increases with the thickness of the quartz, the intensity of the white light in each image tending to a uniform value. Arago's law of complementary colours is verified with plates of a certain thickness, but fails with thin plates, only one of the images appearing coloured, the colouration of the other being lost in the white light.

Industrial Society of Mulhouse.—Session of the Chemical Committee, March 9, 1887.

The Committee received a memoir by Max Becke on a new method of fixing chrome upon cotton. The principle of the method consists in reducing chromic acid by aniline in presence of the fibre. According to the proportions there is fixed an aniline grey and a certain proportion of chromic oxide. If the goods are then dyed in a colouring-matter which takes upon chromic oxide, we obtain very fast shades, resulting from the combination of the chrome lake and the aniline grey.

A sealed paper on a discharge process upon Congo reds, deposited by M. Casanovas, was opened at his request. He prints upon the red cloth, for a white discharge tin acetate, mixed with a small quantity of steam blue. Mixed with berry liquor, it gives a yellow, and with the further addition of steam blue an olive. With these colours may be associated a black with reduced logwood.

C. Kœchlin mentions to the committee the solubility of aniline in soap-lye. A lye containing 125 grms. of dry soap per litre dissolves about 100 grms. of aniline.

Chemical Nature of Vaseline.—C. Engler and M. Boehm (*Dingler's Journal*).—The authors have chiefly occupied themselves with natural vaseline, a product obtained by simple decolouration of petroleum or residues of petroleum with animal black, and then by elimination of the more volatile portions by distillation with superheated steam. The average composition of vaseline is given as 7·10 C : 14·83 H.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Rough Copper.—Can any of your readers inform me what quality of copper is understood by "rough copper," and also if the terms "rough copper" and matte are synonymous?—S. B. F.

MEETINGS FOR THE WEEK.

THURSDAY, Nov. 3rd.—Chemical, 8. "Note on the Atomic Weight of Gold," by Prof. Thorpe and A. P. Laurie. "The Interaction of Zinc and Sulphuric Acid," by M. M. Pattison Muir and R. H. Adie. "Note on Safety Taps," by W. A. Shenstone. "Note on Guthrie's Compound of Amylene with Nitric Peroxide," by Dr. A. K. Miller. "The Dehydration of Metallic Hydroxides by Heat, with special reference to the Polymerisation of the Oxides and to the Periodic Law," by Dr. Carnelley and Dr. J. Walker.

TO CORRESPONDENTS.

R. Romanis.—The diagram illustrating your article is too large to be usefully reproduced within the limits of the pages of this journal.

The LIST will OPEN TO-MORROW, SATURDAY, October 29th, and will Close on or before Thursday, November 3rd. Applications will be received by the National Provincial Bank of England (Limited), at all their branches, or by ordinary letter to the Secretary, enclosing deposit of 10s. per share.

CONDY'S WHITE LEAD COMPANY (Limited). Capital, £200,000, in 40,000 shares of £5. First Issue of 20,000 shares of £5 each at par. Payable 10s. per share on application, £2 10s. per share on allotment, £1 per share three months after allotment.

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ABRIDGED PROSPECTUS.

This Company has been formed for the purpose of acquiring the patent rights and carrying on the business of white lead manufacturers, under Condy's patent, of which H. J. B. Condy and H. B. Condy, the well-known inventors of Condy's Fluid, are the vendors.

The ordinary method of manufacture occupies from four to five months—is most dangerous to the operatives, being attended with much suffering nnd even loss of life from the noxious vapours and poisonous exhalations and dust—requires considerable manipulation in its various processes, is somewhat uncertain in its operation, and the white lead produced is often more or less discoloured.

CONDY'S WHITE LEAD COMPANY (Limited).

ADVANTAGES OF THE PROCESS.

The advantages claimed by Messrs. Condy's process may be shortly described as follows :—

1. White lead of the finest colour and body can be made within seven days, instead of four to five months, the time required by the ordinary process.

2. Any description of metallic lead may be used, including even old lead, all impurities being removed by Condy's process, whilst by the other it is necessary to buy a very good quality of lead, which is called in the trade "refined pig lead," and which has been almost entirely freed, at considerable expense, from all impurities. Old lead is about 8 per cent cheaper to buy than the refined lead.

3. The uncertainty in composition which white lead made by the old process is apt to sustain, is corrected by Condy's process, the composition being identical time after time, of the purest colour that can be made, with covering properties that have been found to excel any of the best known manufactures, and of the pure type described in the leading chemical works.

4. Condy's White Lead has been found to preserve its colour in impure atmosphere in preference to any other.

5. The considerable loss incurred under the ordinary process by droppings amongst the tan (estimated at about 5 per cent), and by the entire waste of the acetic acid employed, is completely avoided.

6. Absence of danger to the workpeople is ensured by the process, since nearly all the operations are effected by machinery, whereas by the ordinary mode of manufacture at every stage the white lead has to be handled.

The actual manufacture of white lead by this patented process has been carried on under Messrs. Condy's personal superintendence, at their works at Battersea for some time past, where they have been manufacturing and selling several tons a week (readily sold to the best colour grinders), with the object of proving on a commercial scale the practical nature of the process and the superior quality of the white lead produced, and the result clearly shows that the lead is produced at considerably under the cost of the ordinary process.

The Directors are advised that the working capital provided for by this issue will be amply sufficient to enable them to erect the necessary plant to manufacture about 100 tons per week, and that this output can be very considerably increased by a small additional outlay. Premises have been secured admirably adapted for this purpose, and are immediately available.

CONDY'S WHITE LEAD COMPANY (Limited).

ESTIMATED DIVIDENDS.

Assuming that these 100 tons only be manufactured and sold per week, or less than one-tenth of the average weekly manufacture in the United Kingdom, it is estimated that this would realise an annual net profit of at least £20,000, equal to a dividend of 20 per cent on the present issue. This is independent entirely of any revenue from royalties, as to which it may fairly be expected that the Company ought to derive an additional profit by means of licences. This should produce profits amounting to a further dividend of from 15 to 20 per cent if only one-fifth of all the white lead manufactured in the country is made under this patent at a royalty of only 30s. or 40s. a ton.

The process is beyond the region of experiment and trial, and with the plant the Directors propose to erect this Company can immediately begin operations as manufacturers of an article proved to be readily saleable at remunerative prices.

It may also be added that Messrs. Condy have gained prize medals for their exhibits at ths only two Exhiditions at which they have exhibited their white lead—a gold medal at the Paris Exhibition, 1885, and a silver medal at the International Inventions Exhibition, London, 1885.

Full prospectuses and Forms of Application can be obtained of the Bankers, Brokers, and Solicitors; or at the Offices of the Company.

American Exhibition closes October 31st,

But, owing to the large number of orders now in, orders will be received and filled there till November 10th.

PROF. A. E. FOOTE of Philadelphia, would call attention to the short time remaining in which choice American Minerals can be had at low prices.

NEW ARRIVALS.—100 pounds of the beautiful Alaska Garnets, in mica schist. Nine boxes of other minerals from America, Germany, and elsewhere.

EDUCATIONAL COLLECTIONS on hand at the very low prices mentioned below. These collections have received the very highest commendations from nearly all leading educators in America. The following institutions have purchased here:—British Museum, Museum of Practical Geology (Jermyn Street). Science and Art Departments of London and Dublin, Cambridge University, &c.

Labels of £1 and higher-priced Collections give name, locality, and in most cases the composition, accompanied by Illustrated Catalogue. Sizes given are average.

NUMBER OF SPECIMENS ..	25	50	100	100	200	300
	In boxes			Without boxes.		
Crystals and fragments	2s.	4s.	8s.	4s.	8s.	12s.
Student's size, larger	6s.	12s.	24s.	£1	£2	£5
Amateur's size, 2½in. × 1½ in.	—	—	—	£2	£5	£10
High School or Academy size, 2½ × 3½ in. Shelf Specimens				£5	£10	£20
College Size, 3½ in. × 6 in,. Shelf Specimens				£10	£30	£60

WHAT BETTER CHRISTMAS GIFT FOR A FRIEND?

SULPHUROUS ACID PLANT WANTED by Sugar Refiner, to produce One to Two Tons daily, 4 @ 6° T. —Address, Box 36, Royal Exchange, Glasgow.

Vitriol and Manure Works.—Foreman Wanted who thoroughly understands the manufacture of Vitriol and Manures, also Phosphate-grinding and the management of men. State age, experience, qualifications, salary expected, and what knowledge of machinery.— Address, Drogheda Chemical Manure Company, Drogheda.

THE CHEMICAL NEWS.

Vol. LVI. No. 1458.

THE RELATION OF SCIENCE TO THE STATE.

VII.

To point out an evil and to explain its causes are but unsatisfactory tasks unless we can indicate some method for its removal. Now unfortunately our national neglect of, or contempt for, scientific research has been too deeply ingrained into the public mind to be swept away by any statute; the three estates of the realm are powerless to silence either the purblind utilitarians who care only for immediate results or the blinder ethicists who are now becoming so rampant. But the feeling which these misleaders have generated may be gradually modified by a variety of methods.

In the first place it is necessary that, as far as the distribution of public honours are concerned, Science—pure Science—should be placed on an equality with Literature, and even with Law. This may seem a startling departure from our present practice; but to us it appears at once just and expedient. It is just, because if a man raises the reputation of his country throughout the civilised world, that country should, in return, do him honour. And in no way can the *prestige* of a nation be more signally enhanced than by its becoming a great focus of research and discovery. What does France, Germany, Russia know or care about our ennobled barristers or judges? What rank do these countries assign to them in comparison with a Faraday or a Darwin? Surely, then, we should not let it be seen that a man of transcendent ability, if he elects to devote himself to Science, must renounce all hopes of public appreciation at home and be content with the honours rendered him abroad.

Our next suggestion relates to a more limited sphere, as if carried out it could affect only men who have studied in our two ancient Universities. It is this: that the Fellowships of the Colleges in these Universities should be attainable by research alone, and should be tenable on the condition of continued research. We would not by any means claim that research in the natural and physical sciences should be the sole condition. Let literary and theological research have also their fair share, but let a certain proportion of these Fellowships be reserved solely as rewards for excellence in advancing chemistry, physics, biology, astronomy, &c. Let no amount of knowledge serve as a passport to these positions unless the candidate had proved himself able to make additions to the existing amount of human knowledge. In other words the applicant should prove himself to be not a mere well-filled bottle or cistern, of what capacity soever, but a flowing spring.

It may be news to some of our readers to be told that this proposal, far from being anything like a confiscation of property, is much more accordant with the intentions of the founders than is the present system. "The general public," says Mr. J. S. Cotton, of Queen's College, Oxford, "are not sufficiently acquainted with the truth that the present generation of Fellows, whether tutors or non-residents, are alike wrongful occupants of their comfortable positions, and usurpers when tried before the bar of history."

It would far exceed our limits were we to quote the statutes of the several Colleges in proof of our position. But whoever wishes for full evidence on the question need only consult a work entitled "Endowment of Research" (H. S. King and Co.). Here (pp. 38 to 51) he will find proof that "the Fellowship system originated in a desire to promote study, and not to promote teaching."

What a splendid revival of Science should we not witness if some twenty or thirty of the most promising minds in the country were, by the occupancy of these Fellowships, enabled to devote their whole time and energies to original research! This reform alone would go very far to remedy the evils of which we have been complaining. It may be said that the benefits of this arrangement would be limited to the graduates of Oxford and Cambridge. True; but is it too much to expect that when the national honour and benefit resulting from the labours of such a body of "researchers" became known, similar endowments would be founded in connection with our more modern universities?

But there are further inducements to original investigation which might be arranged without the necessity of any additional taxation, whether national or local. One of the simplest, though not the least efficacious, of these means would be the enactment that public scientific appointments, professorships, curatorships, the posts of assistants in laboratories, observatories, &c., should be attainable only by the production of original research, and not by "free competitive examination."

Similar should be the case with the highest University degrees, such as those of M.D., D.Sc., &c. Let these be attainable only by dint of original observation or experiment.

We are well aware that our proposals will be exceedingly unwelcome to the whole tribe of "coaches," "grinders," and examiners. If there is ever a prospect of their being carried out these worthies will shout, for longer than two hours, "Great is Cram, of the Britons." For all this we would beg all friends of Science calmly to consider the matter, and if they can suggest any more feasible method of promoting original research not to keep silence.

ON THE THERMAL PHENOMENA OF NEUTRALISATION, AND THEIR BEARING ON THE NATURE OF SOLUTION.

By SPENCER U. PICKERING.

In my communication to the Chemical Society on this subject (*Trans.*, 1887, p. 593) I pointed out that the results proved that—

$$M,R,Aq - M',R,Aq = M,R',Aq - M',R',Aq,$$

and that "the only way, other than by mere chance, in which this equation might be produced, if the formation and dissolution of the salt were independent actions, would be if—

$$M,R - M',R = M,R' - M'R'$$

(the formation of the salt molecules), and—

$$MR,Aq - M'R,Aq = MR',Aq - M'R',Aq$$

(the dissolution of the salt molecules), which view I dismissed as highly improbable and unsupported by any observed facts. In his communication to the Chemical News (vol. lvi., p. 162) Dr. Nicol, however, contends that such a view is not improbable. The experimental evidence which he brings forward in its favour is, that a few meagre experiments seem to show that the vapour pressures of salt solutions indicate a constant difference similar to that which he seeks to prove with respect to the true heat of dissolution of the salt, and that, as the vapour pressure is a direct measure of the attraction of the salt molecule on the water, a constant difference of a similar nature must exist between the true heat of dissolution of salts.

That further experiments should prove this law to hold good with respect to vapour pressures, I have no reason to doubt: it is what may be expected from the existence of similar relations observed in the case of the volumes of salts in solution, the lowering of the freezing-points, and

other physical data; but that the vapour pressures are a measure of the heat of dissolution is a pure assumption, and one for which we have no particle of evidence, and I trust before long to be able to show by experiment that such is not the case.

Even, however, if it should ever be found that the true heat of dissolution of salts conforms to the equation—

$$MR,Aq - M'R,Aq = MR',Aq - M'R',Aq,$$

and that, consequently, the heat of combination of the atoms to form the salt molecules conforms to the similar equation—

$$M,R - M',R = M,R' - M',R',$$

it appears to me that our reasons for regarding dissolution as a chemical action will be greatly strengthened thereby, for this would simply mean that the thermal phenomena of dissolution are of precisely the same character, and follow the same remarkable rule, as those of the combination of atoms in an undoubtedly chemical reaction.

It always seems to me that a great many of the points in dispute between Dr. Nicol and myself ought not in reality to exist, and that they arise through a persistent misunderstanding of each other's views.

Dr. Nicol's view of solution, as I understand it, is that the dissolution of a substance is not the result of chemical action, but of the forces of cohesion and adhesion; whereas my view is that chemical attraction is the principal, and in the generality of cases the only, cause of dissolution. So far we must agree to differ. But there are many facts which Dr. Nicol urges against this chemical, or hydrate, theory, which I think do not touch it in the least, and most of his conclusions from these facts I am perfectly ready to accept.

One great point which he strives to establish is that water of crystallisation (or, as I should prefer to express it, the same hydrate which exists in the solid state) does not exist in solution. But this does not affect the hydrate theory at all. The very essence of this theory—in its original form, at any rate—is that such a hydrate does *not* exist in solution, for a hydrated salt dissolves because it has a tendency to form a liquid hydrate, *higher* than that known in the solid state.

Then, again, another point of attack made by Dr. Nicol is that *all* the water present bears the same relation to the salt. This also may well be the case, even according to the hydrate theory. Taking a concrete instance as an illustration — $CuSO_4$ dissolved in 100 H_2O—two views may be taken of the action on the hydrate theory:—

(1) Some hydrate higher than that known in the solid state—say $CuSO_4,15H_2O$—is formed, and mixes with the rest of the water. This is the commonly accepted view.

(2) The hydrate which is formed by the salt and water is of a more complicated, and therefore more unstable, nature, being a hydrate of a hydrate (comparable with the multiple salts formed by the combination of double salts),—for instance, $(CuSO_4,7H_2O),20H_2O$,—and that this hydrate mixes with the rest of the water present. This is the modification of the hydrate theory which I have advocated (CHEMICAL NEWS, liv., 216).

But on either of these views the particular hydrate existing in the solution at any given moment depends on the relative proportion of salt and solvent, on the temperature, and on other conditions; and, above all things, (a point which Dr. Nicol seems persistently to overlook) these high and complicated hydrates are, as a mere consequence of their complexity, always more or less *dissociated*, and several of them—of a different degree of complexity, and dissociated to different extents—may therefore co-exist in the liquid at the same time. Now the result of this dissociation will be the same as in any other well-known case; the amount dissociated will depend on the relative proportions of its constituents present, and will be affected by the further addition of any one of them (say the water), probably even when the amount added is some hundredfold in excess of the actual amount required by the formula to form the hydrate present. It is, therefore, no argument against the hydrate theory to show that even the 400th H_2O added is affected by the presence of the salt.

But, further, all the water molecules present will *appear* to be in exactly the same condition. In a mass of dissociated hydrochloric acid we have the various units HCl, H, Cl, H_2, Cl_2. At any particular instant of time some of the atoms will be in a different condition from others; yet the gaseous mixture, when examined by most of our methods, appears perfectly uniform, because our experiments extend over a comparative long interval of time, and during that interval each atom of hydrogen and chlorine has been in each of the three possible states, for the same period, and hence they are indistinguishable from their fellows. Precisely the same must be the case of a partially dissociated hydrate in the presence of excess of water,—say $CuSO_4,15H_2O$ in presence of 85 H_2O; although at any given instant the various water molecules would be in a different condition one from the other, this would not be so if our experiments extended, as they do, over a considerable—instead of an infinitely small—period of time. It is true that in the second mentioned view of the hydrate theory, where the hydrate has the more complex constitution, $(CuSO_4,mH_2O)nH_2O$, although the nH_2O may thus be indistinguishable from the rest of the water present, there would be a difference between this and the more intimately (and possibly never dissociated) mH_2O. But the existence of such a difference, and the efficiency of our means of recognising such a difference, are totally different questions, and I maintain, as I have always done, that from the methods of investigation followed by Dr. Nicol it is almost hopeless to expect the detection of any differences which may exist between the combination of various water molecules, for these same methods fail, in most cases, to indicate even the far more intimate combination of the very radicles composing the salt molecules themselves.

DEEP SEA DREDGINGS: THERMOMETRY, TEMPERATURE, AND PRESSURE, DECAY.

By THOMAS T. P. BRUCE WARREN.

ONE of the most interesting subjects in physical science connected with deep sea survey is the matter of temperature.

The chemical changes which take place on the bed of the deep sea are only conjectural, still we have fair reasons for believing that the conditions at the bottom are not favourable to chemical action. We know that a low temperature will itself arrest changes in dead organic matter; added to this we have the antiseptic properties of salt water, but the influence of pressure we are unable to estimate.

There certainly ought to be no difficulty in closely imitating those conditions met with on the bed of the deep sea as regards temperature and pressure; we could then deal with some of those problems connected with biological science which seem at present unsolvable.

I remember, some years ago, experimenting on fresh-water fishes, which were placed in water and submitted to a pressure of 150 lbs. per square inch. By extending these experiments, and providing for a suitable supply of air in the water, we could easily ascertain the depth at which any particular fish could live.

The statement made by Biot, that the air in the swimming-bladders of fishes was richer in oxygen in proportion to the depth in which they lived, is an interesting chemical and biological statement. Are deep sea fishes capable of decomposing water so as to account for this? Or are we to assume that the solubility of oxygen gas in water will explain this? In considering this point we

must not lose sight of the agitation, with the increased facilities of solution which the ocean waves produce. How are we to account for the changes and structural development of sea plants, which are chained by their habits of growth beyond the reach of atmospherical oxygen, unless we assume the medium of solution or aqueous decomposition?

We have some interesting records of the temperature at great depths, by the *Challenger*. Before seeing these readings I met with a curious result in the West Indies, on the average temperature between Cienfeugos and Santiago (Cuba). The copper resistance of a submarine cable laid between these two places showed a mean temperature of 26° F. Portions of this cable were laid in water near and at the landing-places which had a temperature of 80° F., so that we know the main portion must have been laid in water colder than 26° F.

H.M.S. *Druid* reported "No bottom at 2800 fathoms" in the route of submergence. The low temperatures recorded by the *Challenger* in deep water, near Bermuda, confirm my belief that the cable in question must have been laid in water, for some of its length, much below the freezing-point of fresh water. A moderate allowance, based on the principle of approximate differences, will make the lowest temperature 23° F.

A thermometer was designed by Sir William Thomson, I believe, in which the mercury on contracting was followed by a column of liquid which left a stain or mark of its downward track. This thermometer may have given doubtful indications, but still the idea was so simple and feasible that we regret not hearing more about it.

I am not aware that anyone has given a satisfactory explanation for such low temperatures as we find at the bottom of deep water.

We know that in deep water the temperature falls as we go lower down; absence of solar influence and non-circulation are generally regarded as the principal or entire cause. I am unable to endorse this opinion, still I am willing to allow that they may exert some influence.

From some experiments which I made in 1862 I found that pressure alone is capable of reducing the temperature of water. A pressure of 25,000 lbs. per sq. inch was found to lower the temperature fully 20° F. in a short time, the initial temperature being 60° F., which was reduced to 40° F. A jet of water issuing from the cylinder showed this reduction of temperature, so that evidently it was permanently lowered to 40° F. This result alone may have made one pause before accepting it as fact. Fortunately a coil of insulated wire was being experimented on at this time, and the reduction in its copper resistance, when kept there for some hours, corroborated the same fall of temperature.

The pressure produced by a column of water is taken as being proportional to the depth. Now the lowering of temperature does not follow quite so simple a proportion as this, but is expressed by a function compounded of the depth and the temperature of the superincumbent water.

From these considerations it is evident that the readings of an ordinary mercurial thermometer in deep water will have a double source of error, viz., the contraction due to pressure, and the contraction of this contraction due to reduced temperature.

I have tested the electrical resistance of copper wire under various temperatures and pressures, and I have not met with a single case in which pressure exerts the slightest influence. The experiments were made under pressure as high as 50,000 lbs. per square inch. On the contrary, knowing the resistance at any unkown temperature, there is no difficulty in finding the temperature provided the initial resistance has been carefully measured at some known temperature.

I constructed a thermometer for observing deep sea temperatures by changes of resistance, but having to leave England before it was completed I was not able to use it for deep sea purposes. The accuracy of the instrument and its suitability for getting temperatures at inaccessible depths were verified by experiments in deep wells.

A small coil of copper wire, insulated with silk, was made by winding on a metal bobbin (one layer only being made); over this a brass case carefully fitted, and the intervening space was filled in with mercury. The copper was well varnished, to prevent any action of the mercury. The coil was lowered by a cable containing three separate and well-insulated wires, each having the same wire, so that their resistances, compared with each other, were identical. Two of these insulated wires were connected to one end of the coil, and the third wire to the other end of the coil.

As we have to provide for the varying temperature through the depth to the coil itself, we first measure the resistance through the double lead: one of these leads only is used when testing the coil, so that we eliminate the resistance of the leads and get that of the coil only. When the resistance shows no variation after five or ten minutes, we know that the coil has the same temperature as the water surrounding it.

The coil is lowered still further, and another observation taken. This lowering and testing is renewed, and, when the log line paid out for two successive observations is followed by the same resistance, we may fairly infer that the first result showed that we had reached the bottom. The cable itself is the log line, and measures the depth at which our temperature observations are made.

I am not aware that anyone has *proved* that chemical action is arrested in deep water; it is generally assumed that decay does not take place. A very interesting fact, worth placing on record, is that the decay of india-rubber, due to catalytic action, is decidedly arrested: this is, no doubt, due principally to the reduction of temperature, for the decay proceeds rapidly in the warmth.

Although I am aware that the decay of india-rubber is attributed to oxidation, I must say that it is, in my opinion—which is confirmed by experimental observation—a secondary action only.

A NEW METHOD FOR DECOMPOSING ARSENICAL SULPHIDES.

By H. WARREN, Research Analyst.

The following is an outline of a new method of decomposing cobalt speiss, or arsenical alloys of the same:—The regulus to be decomposed is first broken into pieces, about 1 lb. in weight, and suspended by means of oiled string, or other suitable support, in a vessel containing crude hydrochloric acid, to which has been added about 1 oz. of copper nitrate, and the whole allowed to remain for the course of a day or so to undergo dissolution, the copper nitrate reacting with the hydrochloric acid present, forming cupric chloride, while the nitric acid evolved reacts on the metals composing the regulus to form nitrates of the same, which in their turn are again decomposed, generating by so doing sufficient nitric acid to react on a further portion of undecomposed regulus.

The alloy by this treatment is deprived largely of its nickel and cobalt, besides other metals present, such as arsenic and bismuth, which have passed into solution, while the remaining portion having become sufficiently brittle to be readily reduced to a powder, but still containing notable quantities of both nickel and cobalt, is calcined at a low red heat in a plentiful supply of air, by which treatment the residue—consisting of arsenides and sulphides—are wholly converted into arseniates and sulphates, which are readily brought into solution by means of crude hydrochloric acid, and added to the original solution. Metallic iron, in the form of bars, is now brought into contact with the solution, by which means the whole of the copper present is removed as

metallic copper, together with a considerable quantity of the arsenic and bismuth present, the iron passing into solution as chloride, which is again separated by the addition of milk of lime, carrying with it the remainder of the arsenic as basic arseniate of iron. The remaining salts of nickel and cobalt still existing in solution are precipitated together by means of sodium carbonate, as carbonate of nickel and cobalt; they are next disseminated through water, and chlorine gas passed through until saturation, the whole of the nickel by this means passing into solution, the cobalt remaining precipitated. The solution containing the nickel is brought to a state of ebullition, in order to free it from the excess of chlorine present; the nickel precipitated as hydrate, by means of caustic soda, ignited to expel the water present, and reduced to the metallic state by the usual method. It has been found preferable, for various reasons, to separate the calcium salts present, by means of dilute sulphuric acid, before proceeding to separate the nickel and cobalt.

ON THE ANALYSIS OF ALUM CAKE.

By ROWLAND WILLIAMS, F.C.S.

Some months ago an inquiry appeared in the Chemical News with reference to the most accurate method of analysis of alum cake, more especially as regards the estimation of alumina and free sulphuric acid. Having for the last two years devoted a considerable amount of attention to analyses of this description, my experience of the subject may perhaps be of some interest.

In making a complete analysis of alum cake, a large representative quantity of the sample—say 400 grains—should be weighed in a beaker, dissolved in pure water, the solution passed through a weighed filter, and the latter thoroughly washed, dried, and weighed. The insoluble matter may be ignited and examined further, if necessary.

The filtrate is made up to 10,000 grains with pure water. Formerly I took 1000 grains of this solution, = 40 grains of the sample, for the estimation of the alumina and other bases. This was placed in a porcelain basin, boiled with a few drops of nitric acid, and precipitated with slight excess of ammonia, all the usual precautions being observed in the precipitation and washing, so as to ensure the purity of the alumina. Even when working with every possible care, I have, however, generally obtained results somewhat above the truth.

The precipitate contains the alumina and any iron which may have been present, whilst most of the lime, magnesia, potash, and soda will be found in the filtrate. These may be estimated by the usual well-known methods. The iron is best determined volumetrically in another portion of the original solution, and subtracted from the total precipitate with ammonia.

The reason why the alumina generally comes out too high is, I believe, owing to the co-precipitation of a little basic sulphate of alumina, which is very difficult to thoroughly decompose, even by intense ignition over the blowpipe. On this account I have recently adopted the "hyposulphite" method for the precipitation of alumina, as it is easily carried out and gives accurate results. The alumina precipitated by this method is much easier to wash than when thrown down in the usual gelatinous form, and the hyposulphite process also possesses the advantage of separating the alumina from any iron which may have been present in the solution.

The estimation is performed by placing an aliquot portion of the original solution of alum cake in a porcelain dish, neutralising, if necessary, with a few drops of sodium carbonate solution, adding a considerable amount of sodium hyposulphite, and boiling for some time. The precipitate is then filtered off, well washed, dried, and ignited in the usual manner. A certain amount of free sulphur is precipitated along with the alumina, but is, of course, expelled during the ignition.

The iron, lime, and magnesia may be estimated in the filtrate from the alumina, after decomposing the excess of hyposulphite with hydrochloric acid. In complete analyses of alum cakes I now usually make an estimation of the alumina by both methods, as the potash and soda, if present, cannot be determined in the filtrate from the hyposulphite.

The *total sulphuric acid* is best estimated gravimetrically, taking every possible precaution to ensure the purity of the barium sulphate.

With regard to the determination of the *free sulphuric acid* the method most frequently employed is, I believe, the one depending upon extraction with strong alcohol. The process is usually carried out by taking 300 or 400 grains of the sample (if that quantity be available), and digesting all night in a stoppered bottle with strong alcohol. The alcohol (which is assumed to extract the whole of the free acid, but practically nothing else) is then passed through a dry filter, and the residue washed several times with small quantities of strong alcohol. Some operators dilute the alcoholic filtrate with water, and evaporate off the alcohol before titrating with soda. This is not only unnecessary, but causes actual loss of acid by its action on the alcohol when heated. I simply add a drop or two of phenol-phthalein solution to the alcoholic filtrate, and titrate directly with seminormal or decinormal caustic soda.

In order to ascertain the amount of loss which occurs on evaporating off the alcohol, the following experiment was recently made in my laboratory:—Two equal quantities of the sample were taken, and treated with equal volumes of alcohol in the manner above described. One filtrate was titrated with soda directly; the other after evaporating off the alcohol. The following was the result:—

	With evaporation.	Without evaporation.
Free sulphuric acid	0·35 per cent.	0·44 per cent.

In the experiment under consideration, therefore, about one-tenth of a per cent of acid was lost by evaporation with alcohol.

It is necessary that the digestion of the alum cake with alcohol should proceed for several hours, preferably all night, as I have found that contact with alcohol for a short time,—say an hour,—even with frequent agitation, fails to extract the whole of the free acid. In one experiment which I made, bearing on this point, equal quantities of alum cake were digested with strong alcohol for one hour, four hours, and twelve hours. The result was as follows:—

	1 hour.	4 hours.	12 hours.
Free sulphuric acid	0·29 p. c.	0·36 p. c.	0·42 p. c.

As the alcohol process is somewhat tedious when a number of samples are being examined, I have repeatedly endeavoured to devise a shorter method for the estimation of free sulphuric acid in alum cakes and other aluminous compounds. For a long time I confined my attention more particularly to the reaction with Congo red, which is immediately changed to a blue by acid, but is unaffected by solutions of alumina when certain precautions are observed. I hoped to be able to make this reaction the basis for a colorimetric process, but after a considerable amount of work in this direction I have been obliged to abandon the idea, as the results obtained were so unsatisfactory.

My latest experiments have been made with various alkaloids, especially quinine, morphine, and strychnine. These would, presumably, combine with the free sulphuric acid to form sulphates of the respective alkaloids. In order to form the neutral sulphates of the three above-mentioned alkaloids, the following percentages of sulphuric acid are required:—

Morphine.	Quinine.	Strychnine.
17·19 per cent.	30·24 per cent.	14·67 per cent.

The plan which I found to answer best, and therefore adopted, was to add 1000 grains measure of a perfectly clear 10 per cent solution of alum cake to very accurately weighed quantities of quinine, strychnine, and morphine contained in small beakers. After standing a short time, with frequent stirring, the liquids were passed through weighed filters, the undissolved alkaloids thoroughly washed with cold water, dried, and weighed. In this way the amount of alkaloid soluble in 100 grains of the sample was ascertained, and from the figures just given the percentage of sulphuric acid was easily calculated. In making these calculations the solubility of the various alkaloids in pure aluminous solutions was disregarded, and the whole of the dissolved alkaloid was assumed to have combined with the free acid. This will probably account for the estimations invariably giving higher figures than the ordinary alcohol extraction method. I have tried what may be called the "alkaloid" process on several samples of alum cake and sulphate of alumina, and have found the percentage of free sulphuric acid from one-tenth to one-eighth of a per cent higher than those indicated by the "alcohol" method. I append the results of a sample of alum cake recently examined by these methods :—

Free Sulphuric Acid.

Alcohol.	Strychnine.	Quinine.	Morphine.
0·41 p. cent.	0·54 p. cent.	0·50 p. cent.	0·51 p. cent.

It will be seen that all the alkaloids gave somewhat higher figures than the usual method by extraction with alcohol. Probably the latter method will still continue to be preferred, as I believe, on the whole, it yields the most accurate results; but the "alkaloid" process will also be found useful as a check in any doubtful case.

Chemical Laboratory, 9, Albert Square, Manchester,
October 24, 1887.

IMAGE TRANSFERENCE.

By M. CAREY LEA, Philadelphia.

By the term Image Transference I propose to denote certain effects produced on sensitive films, effects curious in themselves, and of interest in connection with the subjects of papers which have recently appeared in this journal.

In those investigations it was shown to be possible to take a film of a silver haloid—chloride, bromide, or iodide, and after making marks upon it with sodium hypophosphite, to obtain a development of these marks, precisely as if they had been impressed by light, but quite independently of any exposure to light. I now propose to show that it is possible to develop on a film of silver haloid a complete image — a print from a negative for example, without either exposing the silver haloid to light, or to the action of hypophosphite, or subjecting it to any treatment whatever, between the moment of its formation and that of its development. The film of silver haloid comes into existence with the image already impressed upon it.

For this purpose almost any silver salt is selected; citrate, benzoate, tartrate, pyrophosphate, &c., answer perfectly. (Some silver salts, the phosphate especially, undergo a slight reduction spontaneously in the dark; these are less suitable). A film of the silver salt selected is formed on paper by the ordinary methods, and this is exposed under the negative to a few seconds of sunshine.

The next step is to convert this film into one of silver chloride or bromide, by plunging it for a few minutes into dilute acid. Ordinary hydrochloric acid may be diluted with six times commercial hydrobromic with two or three times its bulk of water; the exact strength is unimportant. After a short immersion the acid is to be washed out, and it only remains to put the film, now consisting of silver haloid, into a ferro-oxalate developer, when the image appears at once. The chloride or bromide of silver into which the salts above mentioned are rapidly converted by the halogen acid, comes into existence with the image already impressed on it at the instant of its formation.

So that although the substance which received the image is completely broken up and destroyed, the image is not, but is transferred in all its details to the new film of silver haloid.

It is therefore evident that the action of light on all silver salts that can thus transfer an image must be similar in all its essentials to the action of light on the silver haloids. An important conclusion follows, that all such silver salts must be capable of forming sub-salts, else the image could not be transferred. In the case of most silver salts the existence of such sub-salts has not before been recognised, or even suspected; indeed, if I am not mistaken, the existence of such a sub-salt of silver phosphate has been expressly denied. But the image formed by light on silver phosphate can be transferred, therefore sub-phosphate must exist.

These results have also a very direct bearing on the subject of one of my previous papers (Chem. News, vol. lvi., p. 77. I there endeavoured to show that the photo-salts of silver, as obtained by purely chemical means, are identical with the products of the action of light on the silver haloids, both with the material of the latent image and with the visible product of the continued action of light, or rather with the most characteristic constituent of that product. As respects this latter identity, I showed that although the brightly coloured photo-chloride could not be obtained by the direct action of light on silver chloride, it could readily be formed indirectly by acting with light on other salts of silver, and treating the product with HCl.

It might be argued that in this proof one link was wanting, viz. :—Proof that the photochloride obtained by the action of HCl on silver salts, other than chloride, exposed to light, was of the same nature as that obtained by the action of light directly on silver chloride. The results above described supply that link, if it was needed, and show that the photochloride obtained by the action of HCl on silver salts, other than the chloride, exposed to light, has the same capacity for development as has the material of the latent image obtained on ordinary silver chloride.

But this proof itself may be thought liable to an objection. It may be said that as an image was certainly impressed upon the original film, it is not completely proved that the halogen acid had anything to do with the ultimate production of a developed image. The objection would not be well taken, and the experiment may be varied to two ways, either of which eliminates it.

Most silver salts are soluble in nitric acid. After applying the halogen acid it may be washed off, and the paper may be placed in nitric acid until every trace of the original salt (supposing that any escaped the action of the HCl or HBr) is removed, and until it is absolutely certain that nothing is left in the film but the silver haloid. When this is done, the development, so far from being impeded, is rendered only the stronger and brighter. Certainly, therefore, the silver haloid is the essential base of the development.

Another very decisive experiment may be made in this way. Paper prepared with tartrate, oxalate, or almost any other salt of silver, is to be exposed for a minute or thereabouts to a strong light (not under a negative). It is then taken into a dark room, and marks are made upon it either with a glass rod or a camel's hair pencil dipped in dilute hydrochloric or hydrobromic acid. After letting the acid act for five or ten minutes, it is to be washed off, the paper plunged into nitric acid, and after again washing it can be placed in a developing solution, when the marks made will appear black on a white ground. This mode of operating gives a very convincing result. The nitric

acid treatment may be omitted, but when this is done the number of salts that can be used is more limited. The four salts first above mentioned give good results, even without the nitric treatment, but some silver salts undergo a spontaneous change in the dark by keeping a short time, such that when they are placed in a developing solution (without exposure to light) they may blacken instantly all over. Silver tartrate is one of the best salts to operate with, though pyrophosphate, citrate, oxalate, and some others do almost equally well. Sulphate, antimoniotartrate, phosphate, nitrite, and arsenite do not give good results, except with the nitric acid treatment.

With a salt like tartrate or oxalate the experiment is very striking. The paper imbued with it is exposed to light over its whole surface, it is then taken into the dark room, and simply marked with dilute HCl or HBr and washed. Thrown into a developer, all the marks of the halogen acid quickly blacken, proving, first, that the effect of light is transferred from the one salt to the other; second, that the effect as transferred to the chloride or bromide is far more susceptible of development than it was in the original salt. It seems a not unreasonable explanation of this last mentioned fact that the greater sensitiveness of the haloid compounds may depend on their power to combine with their own sub-salts, so that the reduction may commence with the sub-salt, and quickly extend from it to the portion of normal salt with which it is combined; that, on the other hand, other silver salts may not share this power of uniting with their sub-salts, and are consequently more slowly and imperfectly attacked by the developing solution. This explanation may or may not be correct, but seems not improbable.

A curious fact incidentally presented itself in the course of this investigation; that when paper prepared with silver salts, other than the haloids, was exposed to light, and then marked with HCl, the effect of a short exposure, so far as development was concerned, was as great as that of a long one. A piece of paper was prepared with a given salt by non-actinic light. It was then placed between the leaves of a closed book with one end projecting. The book was then placed in the light (very faint sunshine), and the prepared paper was gradually drawn out, so that different portions received progressive exposures from 400 seconds down to 3 seconds. A number of marks were made with HCl diluted, parallel to the end of the paper, so that to each mark corresponded a different exposure from 3″ to 400″. The papers were then placed in nitric acid, washed, and developed. These pieces are before me as I write, and it is impossible to say by the appearances what portion received the 3 seconds, which the 400. The marks are equal in strength on each paper from one end to the other. The salts used were: silver benzoate, tungstate, phosphate, pyrophosphate, and tartrate. The short exposure gave a sufficient basis for development, the longer effected nothing more.

The object of this series of papers has been to offer a new explanation of the nature of the latent photographic image, and to show that it consists neither of the normal silver haloid physically modified, nor of a sub-salt, but of a combination of normal salt and sub-salt. That the sub-salt loses, in this way, its weak resistance to reagents, and acquires stability, thus corresponding to the great stability of the latent image, which, though a reduction-product, shows considerable resistance to even so powerful an oxidiser as nitric acid.

Further, that this combination of normal salt and sub-salts, which constitutes the material of the latent image, can be obtained by chemical means, and wholly without the aid of light. That the forms of these photo-salts, as I have ventured to name them, which correspond to the material of the latent image, are either colourless or nearly so, but that other forms, possessing beautiful and often intense colouration, also exist. With the chloride some of these brightly coloured forms show a ready tendency to reproduce colour, in some cases with well marked and beautiful tints. So that we have here an approach to the solution of the problem of obtaining images of objects in their natural colours from a quite new direction, and probably with better hopes of an eventual complete success than by any of the older methods.—*American Journal of Science*, vol. xxxiv., July, 1887.

GEMS AND ORNAMENTAL STONES OF THE UNITED STATES.

The Saturday Evening Lecture in the working men's cause was delivered, on October 22nd, by Prof. A. E. Foote, of Philadelphia, in the Trophy Hall of the American Exhibition on the above subject to the largest audience that has assembled during the season. The speaker was introduced with some very complimentary remarks by Mr. F. W. Rudler, Curator of the Museum of Practical Geology of Jermyn Street, and President of the Geologists' Association. One reason why so little is known about American gems and ornamental stones in Europe is that there is a ready market in America for everything of the gem character that is produced there. Thus far mining for gems has been of a very desultory character, being principally carried on in connection with mica and other mines, or by farmers and others when they have but little else to do. The emerald and hiddenite mines of North Carolina and the tourmaline mines of Maine are the only ones that have been worked systematically. Gems are the purest forms of minerals, and in nearly all cases are the result of crystalline action. If the conditions of crystallisation are perfect all impurities are excluded. Ruskin, in his "Ethics of the Dust," gives a charming illustration of this by supposing the power of crystallisation to be exerted upon the mud of a path of a manufacturing town. The gems peculiar to America are chlorastrolite, zonochlorite, and hiddenite. Chlorastrolite, or green star stone, is a species which was discovered by Prof. J. D. Whitney, of the United States Geological Survey, about forty years ago. The only place in the world where it is found is Isle Royale, Lake Superior. This island, belonging to the state of Michigan, forty miles long, five miles wide, and about twenty miles from the mainland is composed of amygdaloid trap, in the almond-shaped cavities of which the gem principally occurs. This green stone radiates from a centre and shows a beautiful chatoyance similar to cat's-eye, crocidilite, and other fibrous minerals. In 1868, when Instructor in Chemistry, &c., in the University of Michigan, Prof. Foote led a party from the University that camped for several months on the island.

For the first time the chlorastrolite was found in a vein stone associated with native copper and epidote. The best specimen ever found was secured by our party, and is now in Mr. Foote's possession. The second best one belongs to Mr. Morrison, of London, and the next best one, so far as the speaker knows, belongs to an American lady resident in London. About £300 worth are sold annually. Zonochlorite is a green banded stone similar to chlorastrolite in composition, but discovered by Prof. Foote at Nespigon Bay, on the north shore of Lake Superior. The full description was published in the *Transactions of the American Association for the Advancement of Science* in 1872. It is an entirely novel stone, hardness about 7, takes a very high polish, and if it could be found in sufficient quantities would undoubtedly be extensively used. used. Hiddenite is a green variety of the well-known species spodumene. A yellow variety from Brazil has been cut as a gem for many years. This variety has been known for about seven years, and is fully as beautiful and valued as highly as the diamond. It occurs in connection with emeralds in North Carolina. The locality is worked by a Stock Company, and produces about £500 worth of hiddenite and £600 worth of emeralds annually. One of the finest of these emeralds is in the British Museum.

The fullest series of them is in the collection of C. S. Bement, of Philadelphia. One weighs 8¾ ozs., within a quarter of an ounce of the weight of the most celebrated emerald in England. Of gold qnartz about £28,000 worth is sold annually. Most of this comes from California, where it is not only used as a gem, but in the manufacture of various ornaments. One of these, an imitation of the Cathedral Notre Dame, is valued at £4000. Prof. Foote saw no specimens in Hungary so good, though the gold penetrating amethystine quartz is very beautiful. Though Californian gold is worth about £3 10s. an ounce, nice specimens of quartz readily bring from £5 to £7 an ounce.

Although the flexible sandstone, the gangue of the diamond in Brazil, is found in mountain masses in North Carolina and other states no very large diamonds have as yet been discovered. Many small ones are recorded from California, North Carolina, Virginia, and elsewhere. The largest was found at Manchester, near Richmond, Virginia, weighed 23¾ carats in the rough and 11$\frac{1}{16}$ carats cut. It was valued, when found, at £800, and £1400 was loaned upon it later. Prof. Whitney states that the largest found in California was 7¼ carats. Rubies and sapphires have been found in the rock in the corundum mines of North Carolina, and C. S. Bement has an uncut green one in his collection that would give 80 to 100 carats worth of good stones, one of which would probably weigh 20 carats. This specimen is probably worth £200. The largest red and blue crystal weighs 312 lbs., and belongs to Amherst College. The best sapphires are found in the placer mines of Montana. Asteriated corundums are found in Pennsylvania and elsewhere.

About £2200 of quartz or rock crystals is mined annually. The best localities are Hot Springs, Arkansas, North Carolina, New York, and Virginia. A portion of a mass that must have weighed over 40 lbs. was recently received from Alaska, that cut a hand-glass three inches by five. They are frequently dug up in the pre-historic mounds, and were used by the medicine-men and others for foretelling future events. Amethysts are found in very fine specimens in Pennsylvania, Georgia, Texas, and the Lake Superior region. From the latter region they are very remarkably lined, some specimens showing "phantom crystals," equal to the Hungarian. Near the Yellowstone National Park and in the Chalcedony Forests of Arizona are tree-trunks, some of which are 100 feet long, turned to stone by the action of silicated waters. Some of these trees are still standing upright; others, having fallen, bridge deep chasms. The once hollow cavities of some are lined with amethyst, others with agate. The Arizona agatised or jasperised wood shows the most beautiful variety of colours of any petrified wood in the world, and auout £1500 worth is annually sold for ornamental purposes. Probably the most remarkable locality in the world for smoky quartz or cairngorm stone is Pike's Peak, Colorado. Here it is found, in a graphic granite, associated with Amazon stone, which also makes a very beautiful green ornamental stone. Over £1500 worth of this is annually sold. The largest crystal found—over four feet in length—of good shape, and all suitable for cutting, was recently sold to the Marquis of Ailsa for £20. The rutilated quartz, or Cupid's Arrows, is found in remarkably fine specimens in North Carolina. Perhaps the most remarkable mass is one 7 inches by 3½, now in the collections of the Academy of Natural Sciences of Philadelphia. The crystals of rutile are about the size of knitting needles. Some of the North Carolina rutile has been cut, furnishing brilliant gems closely resembling carbonado. The rutile geniculated till it forms a perfect circle or rosette, from Magnet Cove, Arkansas, is often mounted and worn as a charm. While opals are found at many places in the United States, they do not rival those of Queretaro, in Mexico. Here are found not only the "milky opals that gleam and shine like sullen fires in a pallid mist," but fire, noble, and almost every other variety known. Rhodonite, in specimens suitable for polishing, is found in Massachusetts and New Jersey. At the latter locality were obtained the finest crystals ever seen. The garnets from New Mexico and Arizona are superior to the Cape rubies from South Africa, and from Alaska the most beautiful crystals ever seen, in a setting of grey mica schist, have recently been obtained.

The New Mexican turquoise is mined to the value of about £700 annually. It has recently been described very fully by Prof. Clarke, Curator of the Mineralogical Department of the National Museum, and is especially interesting as being the material from which the "Chalchuhuitls," or most sacred images of the Aztecs, were made. The Indians still regard it as a lucky stone.

Labradorite, lately so popular for gems and ornamental stones, is found in many localities. The tourmalines of Maine are probably the finest in the world. Here are found the oriental sapphire, ruby, and emerald in perfection. The Shepherd and Hamlin collections contain specimens that are unequalled elsewhere.

Topaz has recently been found at Pike's Peak, Colorado, in large quantity. Some masses weighed two pounds each, and very fine clear white stones have been cut, weighing from 125 to 193 carats. The topaz so nearly rivals the diamond in lustre and brilliancy that it is difficult to distinguish one from the other.

Among ornamental stones should be mentioned a very beautiful variety of serpentine from Maryland called verd-antique, which is being largely used in the interior decorations of the Philadelphia Court House. Another variety resembling jade is the green williamsite from Pennsylvania. Alabaster of various colours abounds in many localities, and marbles, some as beautiful as the mexican onyx, are found in nearly every State. The lovely malachite and azurite, jet, and many other gems of minor importance were referred to but briefly on account of limited time.

THE METHODS EMPLOYED IN THE ANALYSIS OF IRON ORES.

TOGETHER WITH A

SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID.*

By A. A. BLAIR.

(Continued from p. 186).

Silica, Ferric Oxide, Alumina, Manganese, Lime, and Magnesia.

ONE grm. was dissolved in HCl, evaporated to dryness, re-dissolved in dilute HCl, and evaporated a second time to render the silica insoluble. It was then re-dissolved in HCl and water (1—3), filtered on a small ashless filter, washed, dried, ignited, and weighed as insoluble siliceous matter. This was fused with five times its weight of dry Na_2CO_3, treated with hot water, and washed into a platinum dish, the crucible treated with acid and carefully rinsed into the dish, the whole acidulated with HCl, evaporated to dryness, treated with water and a little HCl, and evaporated again to dryness. The mass was then treated with HCl and water (1—5) heated to boiling, and filtered on a small ashless filter. The filter was dried, ignited, and weighed. The silica was treated in the crucible with HFl† and H_2SO_4, evaporated to dryness, ignited, and weighed. The difference between this and the weight of the precipitate was SiO_2. Any residue obtained by the treatment with HFl and H_2SO_4 was examined. It might consist of $BaSO_4$ or TiO_2, if either of these existed in the ore, or of a little alumina or ferric oxide, or of a small amount of Na_2SO_4 if the silica was

* From "Mining Industries of the United States."

† The HFl was re-distilled with the addition of a little H_2SO_4 and potassic permanganate from a platinum still, and collected in a platinum bottle, as the crude HFl always contained ferric oxide, beside various sulphur compounds.

not carefully washed. The filtrate from the silica was treated in a platinum dish with NH_4HO, boiled until it smelled but faintly of NH_3, filtered, washed, dried, ignited, and weighed as Al_2O_3, with or without a tinge of Fe_2O_3. To the filtrate, ammonic oxalate was added, the solution was boiled and allowed to stand over night, filtered, washed, and ignited at a high temperature and weighed as CaO.

This filtrate was evaporated down, $NaNH_4HPO_4$ was added, and the solution was well stirred to precipitate the $Mg_2(NH_4)_2P_2O_8$. After standing over night it was filtered, washed, ignited, and weighed as $Mg_2P_2O_7$. Whence 111 : 40 = weight of $Mg_2P_2O_7$: weight of MgO. The sum of the weights of the SiO_2, Al_2O_3, CaO, and MgO should about equal that of the insoluble siliceous matter. When there was a deficiency, alkalies were looked for in another portion. If there was an excess, and the precipitate Al_2O_3 was red, FeO in insoluble matter was determined.

The filtrate from the insoluble siliceous matter was nearly neutralised with Na_2CO_3 solution, 2 grms. of sodic acetate were added, and the whole, after being diluted to about 700 c.c. with hot water, was boiled, and the precipitated ferric oxide, &c., was filtered on a washed filter. The precipitate was washed two or three times on the filter and then transferred back to the beaker with a platinum spatula, the filter was washed with HCl and finally with water, the whole being received in the beaker with the mass of the precipitate. Sufficient acid was added to dissolve the precipitate, and the operation was repeated, the filtrates being added together. The solution of the precipitated ferric oxide, &c., was evaporated to dryness to render insoluble any SiO_2 from the reagents; re-dissolved in dilute acid and filtered into a large platinum dish; the solution was boiled, NH_4HO was added, and the precipitate was collected on an ashless filter, washed thoroughly on the pump with hot water, dried, ignited (finally over the blast), and weighed as $Fe_2O_3Al_2O_3P_2O_5$. The filtrates from the acetate precipitations were evaporated down to about 300 c.c., 2 or 3 grms. of sodic acetate were added, the solution was heated to boiling, and H_2S was passed through to precipitate any Cu, Ni, Co, and Zn.

The precipitate by H_2S was filtered off, and after all smell of H_2S had been boiled off, bromine water was added to the solution. When the precipitated manganic oxide had collected at a gentle heat, and while the solution was still coloured by bromine, it was boiled until colourless, filtered, washed several times, and the manganic oxide was dissolved on the filter in HCl, with the addition of solution of H_2SO_3, which caused its very rapid solution. This solution was evaporated to dryness, re-dissolved in HCl and water, a slight excess of NH_4HO was added, nearly all smell of NH_3 was boiled off, the solution was filtered, any slight precipitate of Fe_2O_3, &c., was re-dissolved, and re-precipitated and filtered as before. The filtrates were added together and excess of—

$$Na(NH_4)HPO_4$$

was added with enough HCl to render the solution decidedly acid, and after boiling for some time, an excess of NH_4HO was added to precipitate the $Mn_2(NH_4)_2P_2O_8$. This was boiled until the precipitate became crystalline and the solution smelled but slightly of NH_3, when it was filtered, washed with cold water, ignited, and weighed as $Mn_2P_2O_7$, which, multiplied by 0·5, gave MnO.

To the filtrate, from the precipitate of manganic oxide by bromine, was added the ammoniacal filtrate from the final precipitation of the Fe_2O_3, Al_2O_3, and P_2O_5; the whole was evaporated down to about 400 c.c., and the lime and magnesia were precipitated as described in the analysis of the insoluble siliceous matter. There were several sources of error which it was found very necessary to guard against in the above analysis, namely, the contamination of the distilled water by silica when it was boiled in glass, the strong action of ammoniacal solutions on the beakers, and the presence of silica, alumina, ferric oxide, lime, and magnesia in many reagents, and especially in sodic carbonate. Distilled water which had been heated over night in a Bohemian flask on the sand-bath was found to contain 52 milligrms. of solid residue to the litre, 26 milligrms. of which was SiO_2; and Fe_2O_3 precipitated from a solution to which water boiled in a flask from 2 to 6 hours had been added, contained after ignition as much as 3 per cent of SiO_2. To avoid this, tin-lined copper flasks were used for heating distilled water, and to avoid the error due to the action of ammonia salts and ammoniacal solutions on the beakers, all the precipitations and evaporations were made in platinum. We were fortunate enough to obtain some remarkably pure sodic carbonate containing only 2 milligrms. of SiO_2, 1½ milligrms. of Al_2O_3, 2 milligrms. of CaO, and 2 milligrms. of MgO to the 100 grms. from Messrs. Powers and Weightman, Philadelphia.

Nickel, Cobalt, and Zinc.

Three grms. of ore were treated as if for the determination of manganese, and the sulphides of Cu, Ni, Co, Zn were precipitated from the boiling solution of the acetates by H_2S. This precipitate was collected on a small filter, washed with H_2S water containing a little acetic acid, dried, ignited in a porcelain crucible, and transferred to a small beaker. It was then treated with HCl and a little HNO_3, evaporated to dryness, re-dissolved in HCl, diluted, boiled, and the Cu was precipitated by H_2S. The CuS was filtered off and washed with hot water, the filtrate containing the Co, Ni, and Zn was evaporated to dryness, re-dissolved in a few drops of water containing not more than two or three drops of HCl, and an excess of K_2NO_2 acidulated with acetic acid added. After standing for a day or two the potassic cobaltic nitrite was filtered off, washed once or twice with a strong solution of potassic acetate, and then, after removing the filtrate, with alcohol to displace the alkaline salts. The precipitate was then ignited very carefully in a porcelain crucible, treated with H_2SO_4 to decompose all the nitrite, made alkaline with NH_4HO, filtered, and the Co was precipitated by the battery; or the ignited precipitate was dissolved in a few drops of HCl, transferred to a small beaker, diluted, and any Al_2O_3 and Fe_2O_3 present was precipitated by boiling for several hours with an excess of sodic acetate. The precipitate of Fe_2O_3 and Al_2O_3 was filtered off, the filtrate was made alkaline with ammonia, and the cobalt was precipitated as sulphide by NH_4HS. The precipitate was allowed to settle, filtered off on a small ashless filter, washed, dried, ignited, and weighed as CO_2S, or treated with H_2SO_4 and zinc and weighed as CoS_4, which, multiplied by 0·4872, gave CoO.

The filtrate from the potassic cobaltic nitrite was acidulated strongly with HCl and heated to decompose all the nitrite, and the NiO was precipitated by an excess of NaHO or KHO, filtered, and the filtrate was tested for ZnO with NH_4HS. If any ZnS was found, the NiO was re-dissolved and precipitated as before, filtered, and the filtrate and washings were added to the first filtrate, the ZnS was allowed to settle, filtered, washed with water containing NH_4HS, re-dissolved in HCl, and evaporated to dryness. This was treated with dilute HCl, filtered, and the zinc was precipitated by solution of Na_2CO_3, filtered, washed, dried, ignited, and weighed as ZnO.

The precipitate of NiO was dissolved on the filter in HCl, the filtrate run to dryness with H_2SO_4, diluted, excess of NH_4HO was added, filtered, and the Ni precipitated by the battery; or the HCl solution was evaporated to dryness, dissolved in a drop or two of HCl, diluted, and boiled with an excess of sodic acetate. Any precipitate of Al_2O_3, &c., was filtered off, excess of NH_4HS was added, then an excess of acetic acid and H_2S was passed through the boiling solution. The precipitated NiS and S were collected on a small ashless filter, dried, ignited, heated with a little ammonic carbonate, and weighed as Ni_2S.

Determination of Ferrous Oxide.

One grm. of finely ground ore was weighed into a flask, A (Fig. 4), of about 100 c.c. capacity, fitted with a rubber

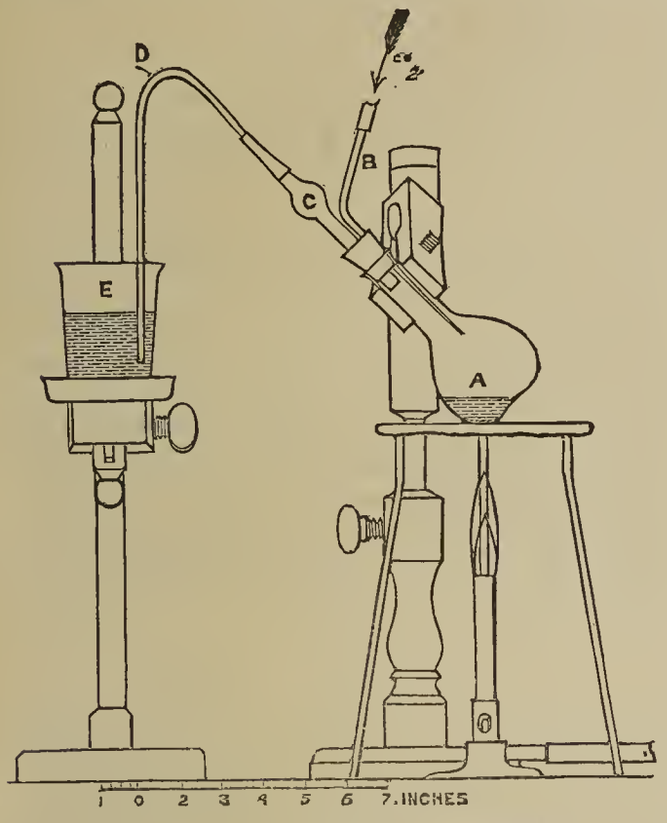

Fig. 4.—Apparatus for determination of FeO soluble in HCl.

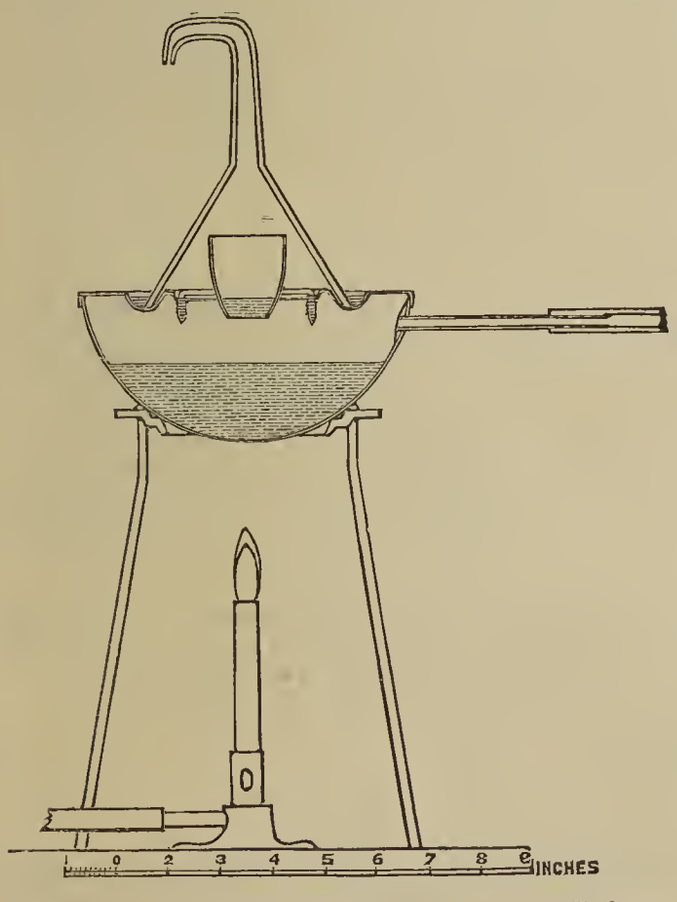

Fig. 5.—Apparatus for determination of FeO in insoluble Residue.

stopper, through which passed two glass tubes, as shown in the cut. Dry CO_2 was passed in through the tube B, to expel the air through the tubes C and D, the latter dipping beneath the surface of the water in the beaker E, and when this was accomplished the stopper was removed, 15 c.c. of strong HCl was quickly poured in, the stopper was replaced, and the ore was dissolved with the aid of heat, the current of CO_2 being continued uninterruptedly. When the solution of the ore was accomplished the source of heat was removed, and the current of CO_2 being temporarily stopped, the water in the beaker B was allowed to run back into the flask, A, until the latter was nearly filled, when the current of CO_2 was turned on again and allowed to continue until the solution in the flask was thoroughly cooled. This was accomplished by removing the tripod, C, placing a dish nearly filled with cold water under the flask, and replacing the tripod. The solution was then washed out into the dish used for titrating, into which 3 grms. of zinc dissolved in 15 c.c. of the dilute H_2SO_4 (1—1) were previously poured, and the whole was diluted to 1 litre. The amount of ferrous oxide was then determined by the potassic permanganate solution. The amount of solution required to colour about 1 grm. of ferric chloride diluted to the same bulk and containing the same amount of H_2SO_4 was subtracted from the amount required for the titration before calculating the amount of ferrous oxide.

Ferrous Oxide in Insoluble Siliceous Matter.

When the insoluble siliceous matter contained iron in the ferrous condition, for instance, in the form of epidote, 1 grm. was treated with HCl diluted, and the insoluble matter was collected on the felt in a pierced crucible, carefully dried, transferred with the felt to an ordinary platinum crucible, and treated, in the apparatus of Fig. 5, with HFl and HCl in a current of CO_2. When entirely decomposed it was allowed to cool, the current of CO_2 being kept up, and then transferred quickly to a dish containing about 1 litre of water and 15 c.c. of the dilute H_2SO_4 and zinc, the crucible was washed out, and the amount of FeO was determined by the standard solution of potassic permanganate.

Sulphuric Acid.

Sulphuric acid may exist in the ore in the form of baric sulphate, calcic sulphate, or as sulphates of iron, &c., formed in the roasting or weathering of an ore containing pyrites. When it existed as baric sulphate it was found, in the analysis of the insoluble siliceous matter, in the residue remaining after the treatment of the silica with HFl. In this case the residue was fused with Na_2CO_3, treated with hot water and filtered. The filtrate was acidulated with HCl, and the sulphuric acid was precipitated by baric chloride and determined as $BaSO_4$, which, multiplied by 0·3433, gave SO_3.

The baric carbonate on the filter was dissolved in dilute HCl, H_2SO_4 was added, and the $BaSO_4$ was finally weighed, which, multiplied by 0·6567, gave BaO. In the other cases 10 grms. of the ore finely ground were treated with water containing a little HCl, filtered, the sulphuric acid was precipitated in the filtrate as $BaSO_4$, and the weight was determined with the usual precautions.

Alumina.

The total amount of the soluble $Fe_2O_3+Al_2O_3+P_2O_5$ was added to the $Al_2O_3+Fe_2O_3$ found in the insoluble siliceous matter, and from this was subtracted the P_2O_5, which gave the total, $Fe_2O_3+Al_2O_3$. From this was subtracted the Fe_2O_3 found by titration; the difference was Al_2O_3. The accuracy of this result depended, of course, upon that of the volumetric determination of the Fe_2O_3. The comparison of many analyses showed that the error due to this need never exceed a few hundredths of 1 per cent, and no direct method was found to yield results equally accurate or concordant.

(To be continued).

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 16, October 17, 1887.

Researches on Drainage. — M. Berthelot. — The nitrogen carried off from the soil by drainage is from 24 to 26 times greater in quantity than the nitrogen brought down in the rain. The total ratio of the ammoniacal nitrogen to the nitric nitrogen in rain-water differs little from 3 : 1. About two-thirds of the rain-water evaporate or are retained in the soil.

The Application of Heat to Cider.—G. Lechartier. —A temperature of 60° arrests all further fermentation in cider, even if it contains as little as 2 per cent of alcohol, and enables them to be kept for twelve months without any change in the proportion of sugar or of alcohol.

A New Method of Preparing Substituted Safranines.—Ph. Barbier and L. Vignon.—The authors have obtained the tetramethylo-diamido-azo-benzol of dimethyl-pheno-safranine by the action of para-nitroso-dimethyl-aniline hydrochlorate upon aniline in an alcoholic solution. In a future communication they will describe a novel method for the formation of safranines by the action of the amido-azo derivatives upon mono-nitro-mono-benzinic carbides in presence of reducing agents.

Formation-heat of Zinc-ethyl.— M. Guntz.— Zinc-ethyl is formed with a considerable absorption of heat, whether we set out from its elements or from ethylene hydride and zinc.

Moniteur Scientifique, Quesneville. Series 4, Vol. i., June, 1887.

Patents taken out at Berlin.—These patents comprise :—

Process for the preparation of oxygenated water, by Siegfried Lustig. L. No. 3927.

Process for obtaining pyrosulphates of the fixed alkalis and ammonia. H. Baum, B, No. 7344.

Manufacture of sodium and potassium. Hamilton Y. Castner. C, No. 1981.

Obtaining from suint hard or soft grease or a product named laneline, as well as free fatty acids. Dr. von Rad. R, No. 2926.

Preparing hydrazoines by the condensation of hydrazo-compounds with the aldehyds. Dr. Hans Cornelius. C, No. 2049.

Azo-colours prepared with the para-diamines of stilbene and fluorene. Berlin Joint Stock Aniline Co. A, No. 1480.

Preparation of Resorcine Blue. Haydn Mozart Baker. B, No. 7027.

Azo-colours derived from the bi- or tetra-halogenous products of benzidine. Ewer and Pick. E, No. 1843.

Preparation, of blue, blue-violet, and violet colouring-matters by condensations of aromatic hydrazo-compounds with aromatic nitroso-derivatives. Dr. Benno Homolkel. H, No. 6207.

Colouring matters of the rosaniline group obtained by the condensation of para-nitro-benzoic aldehyd with hydrocarbides. Dr. F. Stolz. S, No. 1676.

Improvement in the preparation of dimethyl-phenyl-oxypyrazol. Meister, Lucius, and Brüning. F, No. 3008.

Manufacture of a colouring-matter with disulphonic anthraquinone acid. W, No. 4567.

Transformation of the tetra-methylated and tetra-ethylated diamido-benzophenones into the corresponding derivatives of thio-benzophenone. Meister, Lucius, and Brüning. B, No. 7126.

Preparation of a colouring-matter named styrogallol by means of gallic acid or tannin. E. Jacobsen. J, No. 1423.

Improvements in the preparation of blue-black azo-colours. L. Casella. C, No. 1945.

Preparation of the homologues of benzidine. Ewer and Pick. E, No. 1840.

Red colouring-matters prepared with isoquinoleine. Berlin Joint Stock Aniline Co. A, No. 1564.

Scarlet azo-colours obtained by the reaction of tetrazo-diphenyl and tetrazoditolyle with resorcine. K. Oehler. O, No. 827.

Process for separating paratoluidine from its mixtures with orthotoluidine and aniline. A. Wulfing. W, No. 4576.

Preparation of a new naphthol-monosulphonic acid. L. Casella. C, No. 2091.

Yellow colouring matters resulting from the condensation of hydrazine-sulphonic acids with isatine and methyl-isatine. Berlin Joint Stock Aniline Co. A, No. 1621.

Orange and red colours obtained by the reaction of phenanthrenequinone with the aromatic sulphonic hydrazines. Same Company. A, No. 1620.

Azo-colours dyeing cotton directly in an alkaline bath in violet and blue shades. Same Company. A, No. 1583.

Mixed azo-colours derived from the tetrazo-compounds of diphenyl or ditolyl. A, No. 1399.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Destroying Fish.—It is intended to destroy the whole of the pike, perch, dace, and roach in a small lake near here, and to re-stock with lake trout in the spring of the year. The lake is now as low as it can be, and is lower than has been known for the past 20 years. A fish preservation society has been formed, and I write at their request to ask you the best means of destroying these fish. There is about 2,000,000 gals. of water in the lake at the present time, and the water has to travel in a small rivulet before it reaches a trout stream, and of course the fish in this stream must not be damaged in any way.—John Taylor.

MEETINGS FOR THE WEEK.

Monday, November 7th.—Royal Institution, 5. General Monthly Meeting.

— Society of Chemical Industry, 8. "Note on the Comparative Antiseptic Action of Chlorides, Nitrates, and Sulphates," by Mr. C. T. Kingzett, F.I.C., F.C.S. Discussion on Mr. John Ruffle's paper, "The Correct Analysis of Superphosphates, Plain and Ammoniated."

Saturday, 12th.—Physical, 3. "On the Rotation of a Solid Copper Sphere and of Copper Wire Helices when freely suspended in a Magnetic Field," by Dr. R. C. Shettle. "On a Geometrical Method of determining the Conditions of Maximum Efficiency in the Transmission of Power by Alternating Currents," by T. H. Blakesley.

WILLIAM FOX, Analytical Chemist.
LABORATORY:
40, GREAT TOWER STREET, LONDON. E.C.
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MR. J. S. MERRY,
ASSAYER AND ANALYTICAL CHEMIST
SWANSEA.

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THE CHEMICAL NEWS.

Vol. LVI. No. 1459.

NOTE ON THE CORROSION OF THE BOILERS OF LOCOMOTIVES.

By R. W. EMERSON MACIVOR, F.I.C., F.C.S., F.R.G.S., &c.

It having been found that the water supplied to the locomotives running on certain newly-opened lines of railway in the colony of Victoria acted injuriously on the boilers, I was called in to investigate the matter, and, if possible, suggest an easy means of preventing the corrosion The then Minister for Railways, the Hon. John Woods, furnished me with numerous samples of the waters used for feeding the engines on the Colac and Horsham lines, and I found all of them to be highly charged with mineral salts. Next to chloride of sodium, chloride of magnesium was the most abundant constituent, and to this substance I attributed the results complained of, on account of its property of partially decomposing, even when in solution, in such a way as to yield free hydrochloric acid. The engines on the Colac line were supplied from a lake, and did not suffer so much as those on the Horsham line, which were fed with the more saline waters of the Jung-Jung and other creeks.

In the case of the creek waters I may mention that several of the samples contained as much as 700 grains of salts per gallon, of which nearly one-third consisted of chloride of magnesium. But the total salts in Australian waters vary much with the seasons, being often very low in winter and high in summer. Jung-Jung creek water has been found to contain as little as 36 grains per gallon in winter and nearly 800 grains in the middle of the following summer. This accounts for the fact that the corrosive action of the water is insignificant during one part of the year and rapid in another.

The only remedy I could suggest was the addition of soda-ash to the reservoirs in which the waters were stored, and, so far as I know, the results have not been unsatisfactory.

ON REMARKABLE RELATIONS BETWEEN THE SPECTRUM OF WATERY VAPOUR AND THE LINE SPECTRA OF HYDROGEN AND OXYGEN, AND ON THE CHEMICAL STRUCTURE OF THE TWO LATTER BODIES AND THEIR DISSOCIATION IN THE ATMOSPHERE OF THE SUN.

By Professor A. GRUENWALD.

(Continued from p. 188).

Spectrum of the Element *a*. λ=	Solar Spectrum according to Angström. λ=
9842·4	—
7290·2*	7290
6510·2	6511
6150·6	6150·5
5653·5	5653·3

(With possible error up to an Angström's unit. The two first wave-lengths are much more accurate than the following, as they have been deduced from the wave-lengths of H_α and H_β, as most carefully measured by Mendenhall).

* Almost coincides with a telluric line 7290·3 (Fievez).

Spectrum of Element *b*.	Solar Spectrum.
5954	5953·9
5951·8	5951·6
5943	5943·5
5940	5940
5924·4	5923·5
5916	5915·4
5904	5904·6
5899·3	5899
5897	5897
5892·1	5892·1
5886	5885·5, 5886·5
5874·5	Chrom. 5874·9 Helium line.
5855·4	5855·2
5833	5832·5
Lines from 5808 to 5805	5808·2, 5807·2, 5805·7, 5804·4, 5803·5
Lines from 5793 to 5784	5793, 5792·4, 5790·3, 5786·8, 5784·5, 5783·0
5775	5774
5752·5	5752·2, 5751·8
5694·1	5694
5618·2	5618·0
5593·3	5593
5577·3	5577·5
5560·1	5559·6
5535·6	5536·2
5524·3	5524·8
5515·9	5515·5
5511	5511·2
5494·1	5493·8
5485·5	5485·6
5482·3	5482·5
5479·5	5479·9
5455·1	5454·8
	Chrom. 5454·7
5417·2	Chrom. 5417·9
5412·6	Chrom. 5412·4
5403·7	Chrom. 5403·1
	5403·0 to 5403·3
5389·5	5389·6
5376·4	5376·5
5364·0	5364·0 *Fe*, 5364·2
5340·0	Chrom. 5340·2 *Fe* ? Mn. ?
5326·5	5327·0 *Fe*
5274·1	5274·7
5260·1	5259·6
5199·9	Chrom. 5199·7
5187·0	Chrom. 5187·3 (alleged *Ti*)
	&c.

Although the fundamental proposition (I.) was originally deduced only for the combinations of primary elements, it holds good (which is very important) at least with a close approximation for the combination of compound radicles in as far as they really behave like atoms. A proof of this, and at the same time a very important and weighty confirmation of my theory, is the fact that the wave-lengths of nearly all hydrogen and oxygen rays, when multiplied by $\frac{2}{3}$ (the mean condensation factor of H and O on their combination to H_2O) become transformed into wave-lengths of the corresponding H_2O rays, at least so far as the H_2O spectrum is known and is available for comparison.

3. On searching for the reduction-factor of the primary constituent, *a*, of the H_2O spectrum very remarkable relations resulted. It appeared that the ray 4158, into which the main ray H_α 6562 of H is converted by multiplication with 0·6336, is a hitherto unknown ray of the H_2O spectrum, and that by means of the factor $\frac{3}{4}\frac{9}{7}$ it can be reduced to another strong ray λ = 3080 of the H_2O spectrum. The ray 4158 occurs among a group of rays (3986, 4005 to 4645) which Vogel observed in the spectrum of rarefied hydrogen (obtained either electrolytically or from potassium formiate), but whose derivation from H is very doubtful. Considering that on preparing H in these manners an admixture of watery vapour is not easily avoided, it becomes very probable that some, at least, of the doubtful rays, especially the ray 4158, owe their origin to the traces of watery vapour mixed with the hydrogen. These rays are at first very faint, but become visible in presence of hydrogen, being strengthened by its harmonious vibrations. If this conjecture is well founded we may expect that the wave-lengths of those rays of Vogel's which belong to the same group as 4158 can likewise be reduced to the H_2O spectrum by the factor $\frac{3}{4}\frac{9}{7}$. This conjecture proved itself correct to a surprising degree, especially for the rays 3986, 4005, 4047, 4065, 4067, 4078, 4152, 4158, 4168, 4193, 4201, &c., so that these belong to the H_2O spectrum, and on division by 0·6336 pass into corresponding very faint hydrogen rays, as yet unknown with the exception of H_α. Their approximate wave-

lengths are here placed in juxtaposition with the nearest lines of Angström's solar spectrum.

H rays.	Solar Spectrum.
6291	6291·4
6321	6321·5
6387·3	?
6415·7	Chromosphere Young. 6415·6
6418·9	6418·7
6436·2	(6438 ? Ca)
6553·0	?
H_α 6562	6562
6578·3	Chromosphere Young. 6576·9 ?
6617·7	?
6630·3	?

(With possible errors up 1·6 Angström unit).

A careful comparative examination of the spectra of portions of hydrogen purposely mixed with different very small quantities of watery vapour would be very useful, and might furnish experimental confirmation as to the origin of the rays 3986, 4005, 4047 . . . . 4201, &c. The ray 4158 falls very close to another faint ray 4158·7 of the second so-called compound H spectrum observed by Dr. B. Hasselberg if the latter is not identical with the former, and likewise owes its origin to a trace of watery vapour. The same ray was also observed by Plücker in the same manner as well as in atmospheric air and in oxygen.

4. *α.* The wave-lengths of the elementary line spectrum of oxygen resolve themselves into two groups (H′) and (O′), of which the former consists of certain rays of the second compound hydrogen spectrum, and on multiplication by $\frac{1}{4}$ passes over into the corresponding group of the H_2O spectrum.

β. The group (O′) can be divided into two groups (*b*′) and (O″), so that the one group (*b*′) on multiplication with $\frac{2}{3}\frac{9}{2}$ passes into a group of corresponding wave-lengths of the H_2O spectrum, and on multiplication by $\frac{4}{4}\frac{1}{6}$ into a group of homologous wave-lengths of the primary matter, *b*, existing in H in chemical combination. The other group (O″) on multiplication by $\frac{4}{8}$ is converted into a corresponding group of the H_2O spectrum.

γ. The latter group (O″) may again be resolved into two groups of wave-lengths (*b*″) and (*c*). The former, (*b*″), is so constituted that on multiplication by $\frac{2}{3}\frac{1}{2}$, it is reduced to one group of the H spectrum, and on multiplication by $\frac{4}{7}\frac{9}{0}$ to a corresponding group of the H spectrum, which latter belongs to the primary matter, *b*, in H.

The second group, *c*, is converted by multiplication with $\frac{3}{5}$ into a homologous group of H_2O rays.

(To be continued).

THE PHENOMENON OF DECREPITATION IN ORGANIC SUBSTANCES.

By DAVID HOOPER, F.C.S., Government Quinologist.

DECREPITATION is usually defined as "the crackling of certain salts when suddenly heated, acccompanied by a violent exfoliation of their particles." Illustrations of this phenomena are found in some anhydrous salts, such as potassium chlorate, sodium chloride, and plumbic nitrate; certain natural minerals having distinct crystalline structure; and a few imperfect conductors of heat, as glass and cast-iron,—all of which are organic.

Two causes are assigned to the behaviour of these bodies when heated. In the crystals, water is mechanically enclosed between the solid particles, and the explosion is owing to the expansive force of the steam suddenly generated. In the non-crystalline substances there is an unequal expansion of the laminæ which compose the mass, and a consequent breaking up as the heat is conducted into it.

In the analysis of organic compounds it must have been often observed that, in evaporating aqueous and alcoholic extracts to dryness, a crackling frequently takes place as they are cooling, the film of dry extract becomes fissured in all directions, and some portions are detached and fly off or fall to the bottom of the vessel in which the operation is conducted.

A peculiar phase of this phenomenon was noticed some months ago, when examining the bark of *Michelia Nilagirica*. The tannin had been precipitated by cupric acetate, and the washed precipitate in a moist state was dried in a water-oven, and weighed when it ceased to lose water. The tannate of copper, left in a glass dish, in a few moments began to crackle, and fragments of the compound became disrupted and fell like a shower upon the counter, covering it within a radius of some 10 to 12 inches.

This peculiarity was noticed a second time during the investigation of a resin in *Musambra*, a country-made aloes of India. The purified resin, insoluble in acetic acid, was dried at 100° C., and weighed. A few moments afterwards the precipitate began to crack, and great commotion ensued as small splintery fragments were violently ejected on all sides. This continued for about fifteen minutes, when the fountain ceased. The loss of resin amounted to about 5 per centum. Another quantity of this resin was precipitated and dried altogether over sulphuric acid until it became constant in weight; it was then transferred to a water-oven and dried at 100° C. In this case no decrepitation took place after being cooled, but the resin gradually assumed the amount of moisture it held previous to its desiccation at 100° C.

The explanation of the cause of this phenomenon in organic extracts might with very good reason be the same as that which is used in the physical description of the old "Rupert's drop." There seems to be in both an accidental cohesion of matter having elastic properties. The rapid drying of the resin, from a moist to an anhydrous condition, unequally contracted the mass without allowing it an opportunity to assume its natural state when combined with water of hydration. In regaining this water an expansive force was exerted on the exterior portions of the mass, and caused the violent disruption of the particles. As a practical matter this inconvenience might be avoided by the more careful and not too rapid drying of these substances.

In evaporating a chloroformic solution of pure strychnine in an assay of nux vomica, a spluttering often takes place as the final portion of the solvent is being dissipated. This is a different case to those I have been describing. Here the decrepitation, if it may be so called, occurs during the evaporation, and not during or after the cooling. It appears to be due to the assumption of the crystalline state or by the alkaloid on the immediate disappearance of the chloroform.

Ootacamund, India,
October 11, 1887.

THE METHODS EMPLOYED IN THE ANALYSIS OF IRON ORES.

TOGETHER WITH A

SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID.*

By A. A. BLAIR.

(Continued from p. 199).

Calculation of the Analysis.

THE S in the sulphuric acid found as such was subtracted from the total S; so much as was necessary to form the sulphides of Cu, Ni, Co, Zn, Sb with the amounts of these elements in the ore, and supposed to exist in this

* From "Mining Industries of the United States."

condition, was subtracted from this, and the remaining sulphur was calculated to FeS_2. The amount of Fe required for this was calculated to Fe_2O_3, and subtracted from the Fe_2O_3 found by titration. From this was taken the amount of Fe_2O_3 calculated from the FeO found in the determination of ferrous oxide, and the result was the amount of Fe_2O_3 existing in this state in the ore.

Carbonic Acid.

Three grms. of ore were weighed into the flask, A, of the apparatus (Fig. 6), and the connections were made as there shown; 10 c.c. of strong H_2SO_4 were added to 65 c.c. of water and poured into the bulb-tube, B, the stop-cock, C, having first been closed. After the potash bulb and the drying tube were weighed they were attached to the apparatus, the tube, S, was filled with fused $CaCl_2$, being added to prevent the drying tube, R, from absorbing moisture from the atmosphere. The U-tube, O, was

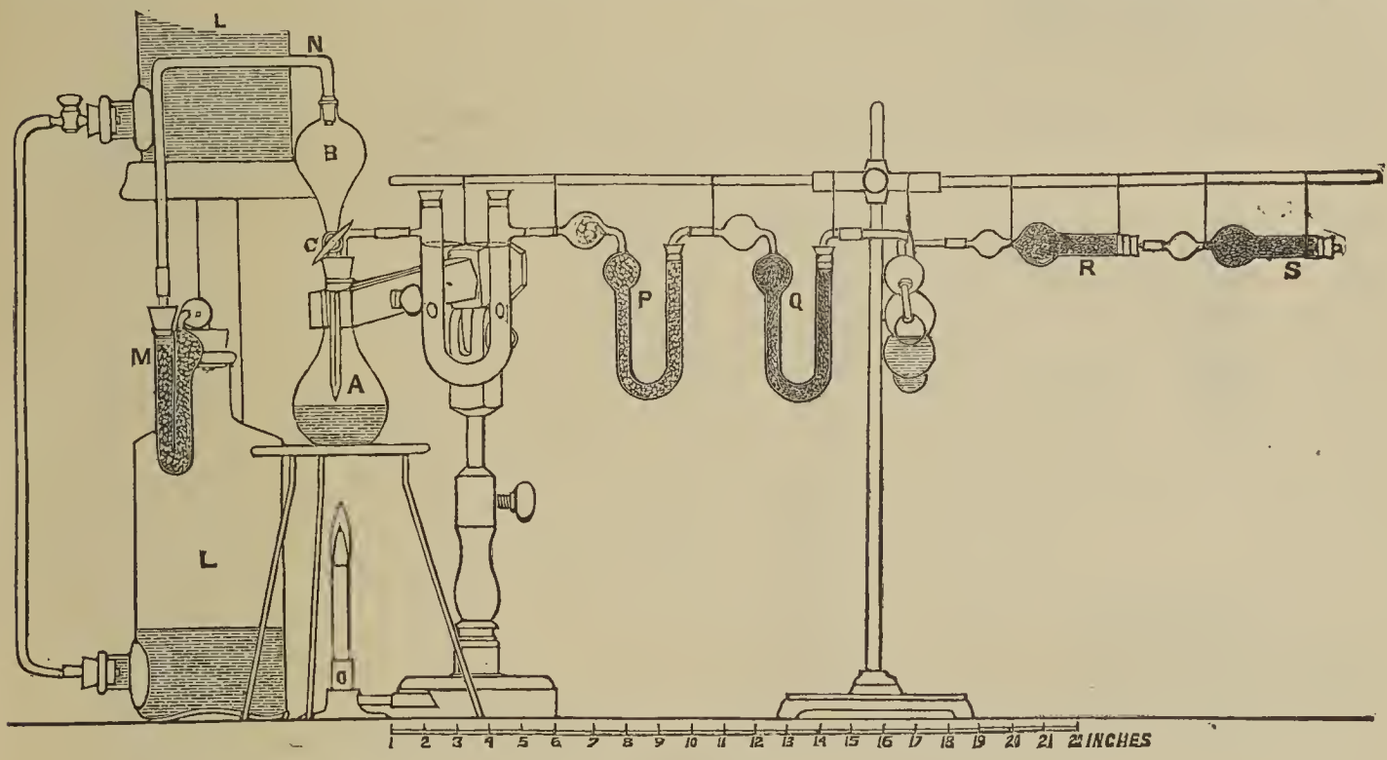

Fig. 6.—Apparatus for determination of CO_2 in Iron Ores.

empty. P was filled with pumice saturated with anhydrous $CuSO_4$, and Q with dried $CaCl_2$. When the connections

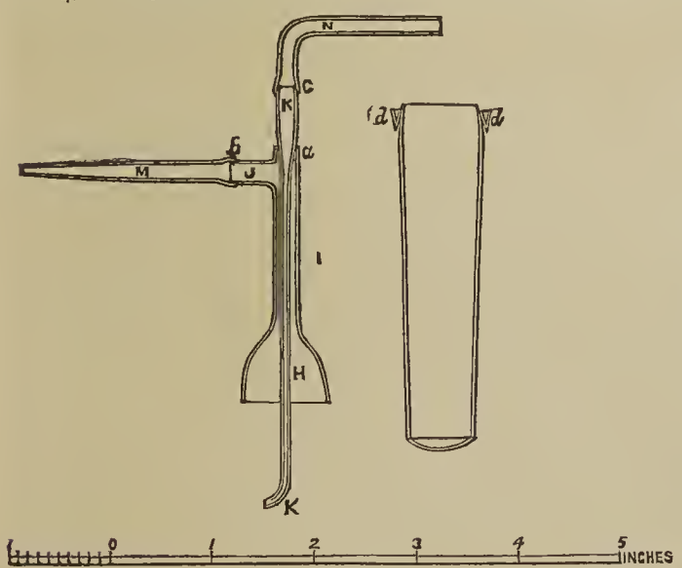

Fig. 7.

were all proved to be tight, the tube, N, was fitted into the neck of the bulb-tube with a piece of rubber tubing, and the acid in the bulb was allowed to run into the flask very slowly, and when it was all in, a slow current of air was forced through the apparatus by means of the bottles L L. The air was freed from CO_2 by potassic hydrate in the tube, M. As soon as the current of air was started, the flask, A, was heated gradually, and finally the solution was boiled until the bend of the tube, O, was filled with condensed water. It was then allowed to cool while the current of air was continued. The potash bulb and the drying tube were detached and weighed with the usual precautions; the increase of weight, of course, was the CO_2 due to the carbonates contained in the ore.

Water and Carbon in Carbonaceous Matter.

Many ores besides blackbands contain carbon; for instance, several ores from New Jersey contain graphite, and nearly all limonites and magnetites contain carbon in organic matter, probably from the organic acids which originally held the iron in solution. As pyrites was also of common occurrence in such ores, it was necessary to devise some method by which the water of composition and the carbon could be determined in the presence of pyrites. In attempting to determine the water by heating the ore in a current of air, some H_2SO_4 was always formed and driven over into the drying tube, and some organic matter was certain to be dissolved if the ore was treated with acid for the determination of the carbon. It was found by careful experiments that when a carbonate of any kind was fused with potassic anhydrodichromate in excess, the CO_2 was all expelled together with any water present, while pyrities treated in the same way was oxidised with formation of potassic sulphate, which was not decomposed even at a bright red heat.

A very practical and easy way to apply this in the treatment of ores was afforded by the use of Dr. Gooch's tubulated crucible,* (Fig. 7), and the process was as follows:—

For ores containing much water or carbonic acid, 1 grm., and for others 3 grms., were weighed into the crucible, A, of Fig. 8, and carefully mixed, by means of a rod or wire, with 7 grms. of $K_2CrO_4CrO_3$, which had been previously fused and powdered; the cap, B, was adjusted, and the whole was placed in the air-bath and heated to 100° for a short time. The crucible was then placed on the platinum

* *Am. Chem. Journ.*, vol. ii, p. 247. Chem. News, vol. xlii., p. 326.

triangle, C, and connected by means of a cork with the weighed tube, D, containing dried $CaCl_2$, and the weighed potash bulb, E, and drying tube, F, were attached, the latter guarded by the $CaCl_2$ tube, G, as can be seen in the sketch.

The cap for the crucible consists of a conical cover, H, drawn out vertically into a tube, I, into which is burned a horizontal tube, J, of the same diameter. Though the top of the tube, I, passes the tube, K, to a distance of ½ inch below the bottom of the cap, the end being slightly bent; K is burned into I at its point of entry, *a*, sealing I at this point. A straight glass tube, M, drawn tapering, is fused to the platinum tube, J, at *b*, and another piece, N, is bent at a right angle to the platinum tube, K, at *c*. A piece of rubber tubing closed with a piece of glass rod at one end, was drawn over the end of the tube, N, the space around the cap in the flange, *d*, was filled with small pieces of neutral anhydrous sodic tungstate, which were fused by means of a blowpipe flame, making an air-tight joint. The mixture in the crucible was kept cool during this operation by dipping the end in a beaker of cold water. The expansion of the air in the apparatus during the heating caused it to bubble through the potash bulb, and the reflux of the solution in the bulb as the apparatus cooled was a good index of the tightness of the joints. When the joints were shown to be all tight the cap was removed from N, and the bottle, L, was connected with N, as shown in the sketch. A slow current of air, freed from CO_2 and water by passing through the tube, Q, containing KHO and $CaCl_2$, was then started through the apparatus, and the crucible was heated very gradually and cautiously by the burner, O. As the steam was gradually driven into the drying-tube it was not allowed to condense at *f*, but was driven forward into the $CaCl_2$ by the heat of a small alcohol lamp applied to the drying-tube at this point. When the greater part of the water had been thus driven over, the crucible was heated by a horizontal flame from the blast-lamp, P, above the level of the mixture, to prevent the latter from frothing up and stopping the end of the tube, K. The bottom of the crucible was gradually heated to a dull red and allowed to remain at this temperature for about fifteen minutes, when the lamps were turned out and the whole was allowed to cool in the current of dried air from the bottle, L. The tubes were then re-weighed; the increase in the weight of D was the weight of the water of composition in the ore, and that of the potash bulb and drying-tube the weight of the total CO_2. This latter, of course, was the sum of the CO_2 due to the carbon of the carbonaceous matter or graphite, and of that due to the CO_2 in the carbonates. The amount of the latter (previously determined) was subtracted from the total CO_2, and the difference, multiplied by 0·2626, gave the carbon in carbonaceous matter, or the graphite.

Alkalies.

The alkalies were generally confined to the insoluble siliceous matter in the ores, but were occasionally found in the portion soluble in HCl. In the former case 5 or 10 grms. of the ore were digested in HCl until only the silicates remained undissolved, diluted, and filtered. The insoluble residue was washed, dried, ignited, and treated in the crucible with HFl and H_2SO_4 until it was entirely decomposed; it was then evaporated down until all the HFl and nearly all the H_2SO_4 volatilised. It was then treated with hot water and a little HCl, if necessary; the clear solution was transferred to a small platinum dish, the Al_2O_3 and Fe_2O_3 were precipitated by NH_4HO, and the solution was boiled until nearly all NH_3 was driven off. It was then filtered into another platinum dish, evaporated to dryness, and heated until all the ammonium salts were volatilised. The residue was treated with a little water, a few drops of ammonic oxalate and excess of NH_4HO, and the solution was boiled and filtered. The filtrate was evaporated to dryness, and the residue was heated to dull redness. It was then treated with water, filtered, and an excess of baric hydrate* was added to precipitate the sulphuric acid and magnesia. The solution was boiled and filtered from the $BaSO_4$, and the filtrate was evaporated to dryness, after the addition of a

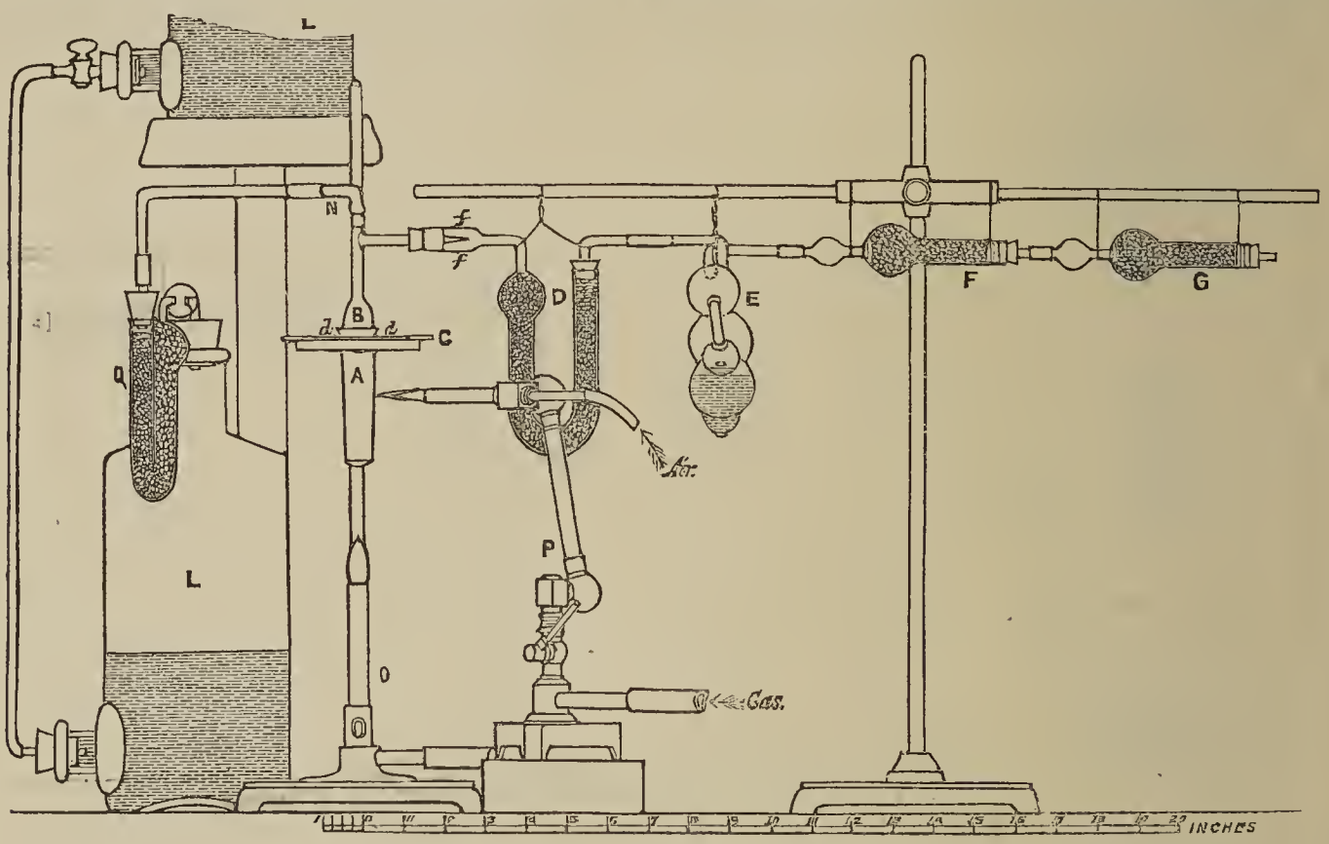

Fig. 8.—Apparatus for determination of Water and Carbonaceous Matter in Iron Ores.

* Made by treating ordinary $BaCO_3$ with tolerably strong HNO_3, and washing the baric nitrate with HNO_3. The baric nitrate was dried and fused until all the HNO_3 was driven off.

little ammonic carbonate and hydrate. The residue was treated with a little water, filtered to get rid of the $BaCO_3$, and the filtrate was evaporated to dryness and heated carefully to volatilise any ammonium salts. The residue was treated with water, filtered into a small weighed platinum dish; the filtrate was acidulated with HCl, evaporated to dryness, heated carefully to a very low red, and weighed as quickly as possible as alkaline chlorides.* The alkaline chlorides were then dissolved in water, any residue was filtered off, weighed, and its weight subtracted from the weight of the chloride, an excess of platinic chloride was added, and the solution was evaporated on the water-bath until the syrupy liquid solidified on cooling. The residue was treated with alcohol 95 per cent, filtered on the felt, washed with 95 per cent alcohol, dried at 120° C., and weighed as K_2PtCl_6, which, multiplied by 0·1931, gave K_2O. The weight of the K_2PtCl_6, multiplied by 0·3056, to reduce to KCl, was subtracted from the weight of the alkaline chlorides, and the difference (NaCl), multiplied by 0·5299, gave Na_2O.

The filtrate from the K_2PtCl_6 was evaporated to dryness in a platinum dish, with the addition of a little oxalic acid to decompose all the platinic chloride; the residue was treated with water, filtered, and any MgO was precipitated by microcosmic salt and weighed as $Mg_2P_2O_7$, which, multiplied by 0·428, gave the amount of MgCl to be subtracted from the weight of chlorides to get the amount of alkaline chlorides.

For the estimation of alkalies in the portion of the ore soluble in HCl, 1 grm. was treated with HCl, diluted, filtered into a platinum dish heated to boiling; a slight excess of NH_4HO was added, and the whole was evaporated to dryness in the air-bath to render the Fe_2O_3 very granular and easy to wash. It was then treated with water, a drop or two of NH_4HO was added, and the Fe_2O_3, &c., filtered off and washed. The filtrate, after the addition of a drop or two of H_2SO_4, was evaporated to dryness, and the ammoniacal salts were driven off by ignition. The residue was treated with water, a little ammonic oxalate was added to precipitate the lime, and the alkalies were determined, as in the former case, after the precipitation of the calcic oxalate.

(To be continued).

* Mixed with a little $MgCl_2$.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, November 3rd, 1887.

Mr. William Crookes, F.R.S., President, in the Chair.

Sir Benjamin V. S. Brodie, Bart., and Messrs. L. O. Simmons, William Bott, and Edward D. Gravill were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Horace Woodward Crowther, Hope Street, West Bromwich; Frank Calder, University College, Bristol; T. Arthur Dickson, 28, Cross Street, Manchester; Charles A. Fawsitt, 4, Maule Terrace, Partick, Glasgow: David Ranken S. Galbraith, Auckland, New Zealand; Joseph C. August Hall, Grosvenor House, Swansea; Casimir James Head, Landore Steel Company, Swansea; James Garnett Heywood, 68, Sutherland Avenue, Maida Vale, N.W.; Walter Hogben, Monville, Seine Inférieure, France; Samuel Lees, Jun., Park Bridge, Ashton-under-Lyne; David Lennox, M.D., 144, Nethergate, Dundee; Eberhard Luttgen, 1814, Mervine Street, Philadelphia, Penna.; Angus Mackay, Sydney, New South Wales; Sidney Martineau, South Road, Clapham Park, S.W.; William Edward Matthews, Kosferd Place, Albert Park, Melbourne; John A. Miller, B.Sc., 16, North Pearl Street, Buffalo, U.S.; John McArthur, 5, Glen Avon Terrace, Partick, Glasgow; John C. H. Mingaye, Taylor Street, Garramatta, Sydney; Archibald R. Ormiston, Heathland, Uddingston; Julius Ostersetzer, Goulding's Chemical Manure Works, Dublin; Andrew William Taylor, Truman Street, Nottingham; Arthur Twivey. 151, Broad Street, Birmingham; José Maria Vargas, 397, Kennington Road, S.E.; John Septibo Ward, 36, Oxford Street, Liverpool; Bartlett W. Winder, Sandon Terrace, Sheffield.

The following papers were read:—

73. "*Note on the Atomic Weight of Gold.*" By T. E. Thorpe, F.R.S., and A. P. Laurie.

In a former paper (*Trans.*, 1887, 565) the authors gave as their final result of twenty-five determinations of the atomic weight of gold the number 196·85, which differs by 0·21 from the value determined by Krüss. Krüss has sought to show, however, that this difference is probably due to the presence of free gold in the bromoaurate of potassium employed by the authors (*Berichte*, 1887, 2365), The authors reply that they were unable to detect any free gold in the salt used by them, and that they therefore altogether dissent from Krüss's conclusion that the lower value of 196·64 is to be preferred.

Discussion.

The President inquired whether the authors had ever attempted to purify the gold by distillation. Stas had stated that it could be volatilised by means of the oxy-hydrogen flame, and he had had occasion to confirm this observation—in fact, gold boiled violently when heated in a lime crucible by means of the oxyhydrogen blowpipe.

Prof. Thorpe replied that no doubt the method suggested might be employed to purify gold. They had obtained their material from the Mint: the only impurity which might have been present was platinum, but it was improbable that it was, as a quantity which might escape detection by qualitative chemical tests appeared to be capable of rendering the gold brittle.

74. "*The Interaction of Zinc and Sulphuric Acid.*" By M. M. Pattison Muir and R. H. Adie.

The experiments described are altogether qualitative. The authors have examined the interaction between sulphuric acid of varying concentration and zinc of different degrees of purity. If pure or nearly pure zinc and moderately dilute sulphuric acid interact at moderate temperatures, they give zinc sulphate and hydrogen only; as temperature and concentration increase the quantity of hydrogen produced decreases, and sulphur dioxide and sulphuretted hydrogen begin to appear. With concentrated acid and nearly pure zinc the chief gaseous product is sulphur dioxide. When commercial zinc is used sulphur dioxide and sulphuretted hydrogen are produced at almost all temperatures, and even with acids as dilute as—

$$H_2SO_4 \cdot 100H_2O.$$

Zinc sulphate is the only solid product of the interaction at any temperature or concentration of acid. The reaction with platinised zinc-foil resembles that with commercial zinc; in both cases sulphur is formed at moderately high temperatures when fairly concentrated acids are employed. Variations in the relative mass of zinc employed are without regular influence on the nature of the products of the change. The possible sources of the sulphur and the sulphur compounds are discussed in the light of the tabulated experimental results. The general conclusion is that the interaction between nearly pure zinc and sulphuric acid of different degrees of concentration is chiefly a direct chemical reaction; but that when less pure zinc is employed the reaction is largely electrolytic. The marked influence of concentration and temperature, in every case, makes it probable that the reactions are many and complex, and that they occur between zinc and various molecular aggregates of H_2SO_4 and H_2O, or of H_2SO_4, SO_3, and H_2O.

Discussion.

In answer to Mr. Groves, Mr. Muir said that they had not ascertained whether the sulphur which was produced was the soluble or the insoluble modification.

Replying to Mr. Harcourt he said that they had not attempted to take into direct account the influence of varying amounts of zinc sulphate; he thought, however, that if it had exercised any particular influence this would have been noticed in the course of the experiments, as the conditions had been very greatly varied.

Dr. Armstrong expressed his surprise that the authors should have made in the beginning of their paper a halting confession that interactions such as that between sulphuric acid and zinc were "to some extent at least electrolytic;" and still more that they should state the opinion that their experiments afforded evidence that in the case of approximately pure zinc "chiefly direct chemical interaction" takes place. It was very remarkable that chemists did not recognise, as physicists had done, that the chemical and electrical phenomena were in such cases absolutely interdependent. The authors had brought forward a large amount of valuable information in their paper, but he could not conceive how any of their evidence could be interpreted as proof of direct chemical interaction—whatever that expression might mean.

In reply to Dr. Armstrong, Mr. Muir stated that by the expression "direct chemical interaction," as compared with the expression used when speaking of the action between sulphuric acid and commercial zinc, viz., "a reaction partly chemical, and also to a large extent electrolytic," the authors meant that in one case zinc, sulphuric acid, and water interact in the manner usually called chemical, and that the products are either hydrogen and zinc sulphate, or, with a different concentration of the acid and a different temperature, hydrogen, zinc sulphate, and sulphur dioxide; while in the other case, besides this change, another occurs, viz., the decomposition of the acid by the electric current produced in the chemical reaction occurring between the acid, the zinc, and the other metal or metals in the specimen of zinc used. The first change might be, and probably was, electrical as well as chemical; but, if so, the generally used term, "chemical interaction," is here employed to include the electrical as well as the chemical part of the whole occurrence.

75. "*Note on Safety Taps.*" By W. A. Shenstone.

The author has previously pointed out ("Methods of Glass Working," pp. 64 to 66) that the safety taps recently introduced are open to the rather serious objection that they offer no special resistance to the passage of air in the direction in which leakage is most likely to occur, and that therefore such taps are only trustworthy when employed in conjunction with suitable mercury traps. But it had hitherto escaped his notice, and probably that of others also, that even when so protected these taps are still of unsatisfactory construction, as when the properly lubricated plug of the tap is brought into position the space below the plug remains full of air. If the tap be well made, nearly all this air will remain there during the exhaustion of any vessel that may be attached to either arm of the tap; but afterwards, especially if the lubrication of the tap becomes imperfect, air will gradually find its way from below the plug into any apparatus that may be attached to the tap.

To remove this imperfection a very simple alteration only is required, viz., that the plug shall be drilled so that when the tap is open there is free communication between the space below the plug and the contents of any apparatus of which the tap may form a part.

Discussion.

The President exhibited and described two safety taps, the one sealed in one, the other in two directions, by mercury, which were not open to the objection raised by Mr. Shenstone.

Mr. Shenstone subsequently pointed out that the chance of leakage was very much reduced by placing the two arms of the tap at different levels and bringing them into communication by drilling a hole diagonally through the plug; and he particularly insisted on the importance of this modification of the ordinary method of construction.

76. "*Note on Guthrie's Compound of Amylene with Nitrogen Peroxide.*" By A. K. Miller, Ph.D.

In the examination of the products of the manufacture of oil-gas (Armstrong and Miller, *Trans.*, 1886, 74) the want of a method of identifying different unsaturated hydrocarbons was keenly felt, and experiments in more than one direction are in progress which it is hoped may lead to a satisfactory solution of the difficulty of analysing complicated hydrocarbon mixtures of a similar nature. It appeared to be not improbable that nitrogen peroxide might prove a valuable reagent for the recognition of some of the constituents, as it was known to combine with certain unsaturated hydrocarbons to form well-defined crystalline derivatives; and it was further hoped that perhaps a reagent might be discovered which would characterise N_2O_4, and might be of surface in studying the vexed question of the existence of gaseous N_2O_3. It was conceivable that the formation of crystalline compounds depends on a particular molecular grouping of the carbon and hydrogen atoms, and that they will be producible from a homologous series of like constituted hydrocarbons only and not from their isomerides. A few preliminary experiments only have as yet been made, the work having been postponed from last winter owing to the great difficulty of working with such very volatile hydrocarbons and such comparatively unstable substances in hot weather. The reason for already bringing the subject before the Chemical Society is the recent publication of a paper by Wallach (*Annalen*, ccxli., 288), who has to some extent anticipated the author's line of work.

Many years ago, Guthrie (*Annalen*, cxix., 83) showed that when commercial amylene and nitrogen peroxide were brought together, combination took place, the products being a definite crystalline substance, $C_5H_{10}N_2O_4$, which decomposed sharply at 95°, and an oil. Although commercial amylene in known to consist chiefly of trimethylethylene, no proof had been given that Guthrie's compound is derived solely from this hydrocarbon, and not from some other constituent. This being a point of importance in connection with the research as indicated above, pure trimethylethylene was prepared from commercial amylene by agitation with sulphuric acid, &c., according to Wischnegradsky's method (*Annalen*, cxc., 328). The action of pure nitrogen peroxide on trimethylethylene and on the residual amylene was then separately examined. The trimethylethylene, dissolved in either carbon bisulphide or glacial acetic acid cooled by iced water, was converted almost entirely into Guthrie's crystalline compound; some green oil was also produced, but this crystallised for the most part on standing. On crystallising the product from benzene, prismatic crystals were obtained which decomposed sharply at 99°. No signs of the needles described by Wallach (*loc. cit.*) were observed.

On submitting a small portion of the residual amylene to the same treatment, no crystals were produced, and on pouring the product into water a separation into three layers was observed. The lowest layer consisted of a heavy oil which could not be made to crystallise by cooling to $-10°$ or by exposure to air. The uppermost layer was very volatile and consisted in all probability of pentane originally present in the amylene.

Experiments were also made with normal amylene and normal hexylene; these both yielded oily products heavier than water, and which also refused to crystallise.

From these results it would appear that trimethylethylene is the only constituent of commercial amylene which yields a crystalline derivative with nitrogen peroxide. It remains to be seen how the isomerides behave.

Discussion.

Professor Dunstan asked whether Dr. Miller had examined the action of reducing agents on Guthrie's compound. He suggested this as a test of the correctness of the formula proposed by Wallach, which represented the compound as a nitrosyl nitrate, a view which Victor Meyer had previously rejected because he obtained all the nitrogen in the form of ammonia on reducing with sodium amalgam. The action of ferrous hydroxide might decide the question, since nitrosyl, if present, would probably yield hyponitrite, while the nitroxyl, being unattacked by the weak reducing agent, would form amyl nitrate.

Dr. Miller replied that he had not.

77. "*The Dehydration of Metallic Hydroxides by Heat, with Special Reference to the Polymerisation of the Oxides and to the Periodic Law.*" By Professor Carnelley, D.Sc., and Dr. James Walker, University College, Dundee.

The object of this investigation was—*First*, to ascertain whether some light could be thrown on the question of the polymerisation of the metallic oxides (*cf.* Henry, *Phil. Mag.* [5], xx., 81) by heating certain hydrates at regularly increasing temperatures, and determining the degree of dehydration thus produced. In this way it seemed probable that data could be obtained for the construction of curves which would indicate whether any compounds were formed intermediate between the normal hydrates and the corresponding oxides, and thus give some information in regard to the general phenomena occurring during the dehydration, whilst the composition of those compounds, if formed, might also afford some clue to the true molecular weights of the oxides. *Second*, to determine the minimum temperature of complete dehydration of the metallic hydroxides with a view of ascertaining whether this temperature was a periodic function of the atomic weight of the positive element.

In the paper the methods of working and the full results are given, together with diagrams of curves in which these results are represented graphically. The general conclusions arrived at are as follows:—

1. Precipitated antimony trioxide is anhydrous. On heating it underwent the following changes: Sb_2O_3 or $Sb_{20}O_{30}$ stable up to 360°; then rapid absorption of oxygen with formation of $Sb_{20}O_{32}$ (?); the latter comparatively stable to 415—440°; then further absorption of oxygen with formation of $Sb_{20}O_{35}$ (?); the latter comparatively stable to 500—565°; third absorption of oxygen with formation of Sb_2O_4 or $Sb_{20}O_{40}$; the latter stable from 590° to above 775°.

2. The following definite stable hydrates appear to exist:—

(*a.*) $Ag(OH)$, stable up to about 100°, then rapid loss of water with formation of Ag_2O; the latter stable to 180—270°, then reduction to metallic silver; this reduction complete at 300—340°.

(*b.*) $Hg(OH)_2$, stable up to about 100°; complete dehydration to HgO at about 175°, when incipient decomposition into Hg and O_2 commences, followed by full decomposition at about 415° to 440°.

(*c.*) $CeO_2 \cdot 2H_2O$ or $Ce(OH)_4$ = ortho-ceric hydrate. This hydrate was formed on heating precipitated hydrate of cerium dioxide to about 385°. It remained stable from about 385° to 600°. It was of a light yellow colour. On heating to over 600°, it underwent dehydration to CeO_2, and became salmon coloured. This is the only definite stable hydrate of the oxides RO_2 of the silicon-titanium group obtained. In other respects cerium hydrate on dehydration behaved like the hydrates referred to in § 5.

(*d.*) $5Co_2O_3 \cdot 8H_2O$.—This was the composition of air-dried cobaltic hydrate, and was perfectly stable up to 75°.

3. The following data in regard to the action of heat on the hydrate of Pb_2O will possibly be of interest in the manufacture of red lead:—Hydrate dried in air = $3PbO_2 \cdot H_2O$; complete dehydration about 230°; PbO_2 stable up to about 280°; loss of oxygen with formation of Pb_2O_3 at 280—290°; Pb_2O_3 stable at 290—360°; loss of oxygen with formation of Pb_3O_4 at 360—415°; Pb_3O_4 stable at 415—530°; loss of oxygen with formation of PbO at 530—580°; PbO stable from 580° to above 815°; PbO fused somewhere between 585° and 630°.

4. Air-dried thallic hydrate = $Tl_2O_3 \cdot H_2O$, but unstable on heating; complete dehydration to Tl_2O_3 at about 230°; Tl_2O_3 perfectly stable at 230—360°; reduction to $3Tl_2O_3 \cdot Tl_2O$ at 360—440°; $3Tl_2O_3 \cdot Tl_2O$ perfectly stable at 440—565°; rapid loss of oxygen and volatilisation of Tl_2O formed at 585—815°; the rate of loss gradually diminishing after fusion at 630°; remaining Tl_2O_3 constant from 815° upwards.

5. An examination of all the results shows that, with the exceptions referred to in § 2, there was no certain indication of the formation of definite hydrates, which were stable through any but possibly a small range of temperature. From this we must conclude, either that there are no definite hydrates formed on heating at gradually increasing temperatures, or that a very large number of such hydrates are produced under these conditions, but are so unstable that a further rise in temperature is sufficient to convert a higher into a lower hydrate. Of these, the second alternative is, for reasons given, by far the more probable.

The results accord entirely with Professor Henry's theory that the known metallic oxides are polymers $n(RO_x)$ of the unknown simple oxides (RO_x). The results also show that in most cases, especially those of SiO_2, TiO_2, SnO_2, Al_2O_3, &c., the coefficient n of polymerisation must be very large, as might be expected from the infusible character of these oxides. Minimum values for this coefficient are indicated in some cases.

6. The retention of water by many oxides at comparatively high temperatures, at and above a red heat, is noteworthy. This is especially interesting in the case of the hydrate $Ce(OH)_4$, which is stable to so high a temperature as 600°. The retention of water at such high temperatures illustrates the great importance in quantitative analysis of the thorough ignition of hydrates before weighing.

7. The minimum temperature of complete dehydration is a periodic function of the atomic weight, as follows:—

(*a.*) *For normal oxides of odd members of the same group, the minimum temperature of complete dehydration diminishes as the atomic weight of the positive element increases.*

(*b.*) *For even members of the same group it increases as the atomic weight of the positive element increases.*

(*c.*) *For normal oxides of elements belonging to the same period the minimum temperature of complete dehydration diminishes from the beginning to the middle, and then increases to the end of the period.*

These results accord with the heats of combination of the normal oxides with water in the formation of hydrates.

8. Of two oxides belonging to the same group, the one which requires the highest temperature for complete dehydration will usually combine at any other lower temperature with a greater quantity of water per molecule of oxide, though this is not always the case, the pairs SiO_2, SnO_2, and Al_2O_3, In_2O_3 being marked exceptions. From this we may conclude that the order of affinity of the oxides for water is *usually* the same both in *intension* and in *extension*, though not always so.

2. Changes of colour on dehydration which are *permanent on cooling* usually indicate the formation of a definite hydrate, or that the dehydration is complete, or that some other definite chemical change has occurred.

78. "*The Bromination of Naphthalene β-Sulphonic Acid.*" By G. Stallard.

The author has revised and extended the work of Darmstädter and Wichelhaus (*Annalen*, clii., 303) and

Jolin (*Nova Acta Soc. Upsal.*, 1877). He finds that when a strong solution of $C_{10}H_7 \cdot SO_3K(\beta)$ is acted upon by 1 mol. prop. of bromine, a mixture of mono- and dibromo-salt is precipitated, consisting chiefly of the former. Their separation is best effected by fractional crystallisation of the copper salts: the mono-salt separates out first in the form of very small pale green rhombic plates, while the dibromo-salt remains in the mother-liquor, and eventually comes down from a sufficiently concentrated solution in the form of long, sage-green, seaweed-like filaments. The mono-salts examined are the potassium (anhydrous), barium ($+H_2O$), calcium ($+H_2O$), and sodium ($+H_2O$) — which all crystallise in colourless needles—and the copper salt ($+8H_2O$). The dibromo-salts examined are the potassium ($+\frac{1}{2}H_2O$), barium ($+3\frac{1}{2}H_2O$), calcium ($+2H_2O$), and sodium ($+H_2O$)—which were all obtained in colourless needles—and the zinc salt ($+9\frac{1}{2}H_2O$), which separated from solution in the form of a slightly opalescent, almost translucent jelly, and the copper salt ($+7H_2O$).

The constitution of these bodies is shown by the fact that the monobromo-salts yield on hydrolysis α-bromonaphthalene, while the dibromo-salts give the so-called β-dibromonaphthalene, which is the $\alpha'\alpha^4$ modification. Hence the tribromonaphthalene (m. p. 86·5°) which Jolin prepared from the dibromo-sodium salt by the action of PBr_5, is either the $\alpha'\beta^2\alpha^4$ or the $\alpha'\beta^{2'}\alpha^4$ modification. The first of these formulæ, however, is inadmissible, since it has been already assigned with good reason to Meldola's tribromonaphthalene of m. p. 114° (*Chem. Soc. Trans.*, 1883, 4) from dibromo-α-naphthylamine, and hence the constitution of the mono- and dibromo-sulphonic acids above-mentioned must be $Br : SO_3H = 1-2'$ and $Br : Br : SO_3H = 1 : 4-2'$.

Further experiments to test the correctness of this conclusion are in progress. The monobrom-acid appears to correspond to the chloro-sulphonic acid which Cleve has recently (*Berichte*, 1887, 72) obtained from nitro-naphthalene-β-sulphonic acid.

79. "*The Constitution of the three Isomeric Pyrocresols.*" By W. Bott, Ph.D.

By reducing α-pyrocresol by means of hydrogen iodide the author has obtained, among other products, a hydrocarbon having the properties of a paraffin. and approximately of the composition $C_{15}H_{32}$; zinc-dust appears to reduce pyrocresol in a similar manner—but with difficulty. Attempts to displace the oxygen in pyrocresol by chlorine by means of phosphorus pentachloride were attended with little success—all attempts to purify the product having failed. From these results and those previously obtained by Schwarz and himself, the author draws the conclusion that the pyrocresols are compounds of the type of phenyl ether.

Discussion.

In reply to Dr. Armstrong, who asked why so peculiarly unfortunate a name as "pyrocresols" had been assigned to compounds which were neutral substances and not "ols," *i.e.*, phenols, and could not possibly bear any simple relation to the cresols, Dr. Bott said that he was not responsible for the name; it was selected by Schwarz because they were by-products of the manufacture of cresols and their homologues, and were obtained when the retorts in which distillation was effected became overheated.

80. "*Preliminary Note on Certain Products from Teak.*" By R. Romanis.

The author finds that alcohol extracts a soft resin from teak, but no oil or varnish. On distilling the resin he obtained a crystalline substance which he also found to be present in considerable quantity in the tar resulting from the destructive distillation of teak. The analyses which he has made for the crystals point to the empirical formula C_9H_8O; on oxidation with nitric acid they yield what appears to be a quinone of the formula $C_{18}H_{16}O_2$.

At the next meeting, on November 17th, there will be a ballot for the election of Fellows, and the following paper will be read:—

"Zinc-copper and Tin-copper Alloys," by A. P. Laurie.

CORRESPONDENCE.

EXAMINATION OF OILS.

To the Editor of the Chemical News.

Sir,—My letter which appeared in the Chemical News (vol. lvi., p. 168) was somewhat hurriedly written, and as Chateau's work was not at hand I simply referred to Fontenelle. Mr. Allen's letter, which appeared in reply to this, confirms my belief in the statement which I made, and which has opened up this correspondence.

I propose to answer Mr. Allen's letter (vol lvi., p. 188) more fully. I must first point out that by "practical acquaintance" I mean experience in using. One may know of a test, but, if another method for doing the same thing has been worked up, no one is justified in giving it up unless something is gained. Hausemann's method differs from what I use entirely, and although it is a reaction which recognises an acid it can be made quantitative. I have no difficulty with it; it is applicable to any oil, fat, or resin which I have met with for quantitative results.

Hehner's method of examining butter, and Reichert's method of determining volatile fatty acids, I have not had occasion to use myself; but Mr. Edwin Bruce Warren is working on these methods, in connection with butter adulterations, in my private laboratory.

Gladding's process for separating fatty and resin acids I know, but do not use, as I effect the same thing in another way. Fontenelle (p. 415) gives a method, which he speaks highly of, for separating resin and rosin oils.

The improved methods of determining specific gravities, &c.: I recognise here a method which at first I could not identify as the "tin pot concern," which I have always called Laurot's Oleometer, and which consists essentially of a tin vessel for containing the oil, which is placed in another tin vessel serving as a water-bath. I use this for determining the specific gravities of tallow, palm oil, and cocoa-nut oil, or any viscous oil; in fact, in winter it is generally used. For waggon-grease and similar lubricants I use an ordinary glue-pot. If we substitute a glass beaker, or tube, for the inner pot, we get what Mr. Allen refers to. A description of Laurot's Oleometer will be found in Chateau.

Because I suggested the elimination of air-bubbles, &c., Mr. Allen says that I am "not acquainted with their real object or character." I presume Mr. Allen means expansion coefficients. Does he know that Saussure did a great deal this way, and that his results are scattered under the principal oils in Chateau's work?

It will be necessary here to say a few words on the "antiquated works of Chateau and Fontenelle." Fontenelle was, I should fancy, an engineer, and from what I know I suppose that there is scarcely an oil-works in the United Kingdom, in Europe, or America, which is not indebted more or less to Fontenelle's drawings of machinery, description of processes, &c.

Chateau:—About 1862 La Société Industrielle de Mulhouse offered a premium for a method for analysing oils. Chateau gained the prize. Amongst other tests which he subsequently gave was the saponification method and iodine absorption. ("Chateau Essais Personnels," p. 70; see also "Chlore, Brôme, et l'Iode," p. 16.

Mr. Allen wants figures for six oils before he will believe this. It is certainly very singular that Chateau gives no figures of results, nor particulars; still any chemist could carry out these tests even from the little that is said.

The bromine process is due to Cailletet (Chateau, p. 66). It is also remarkable that only one experimental result is given. Chateau says that the idea is excellent, and suggests making the process volumetric (Chateau, p. 70).

The separation of fatty acids, resins, and hydrocarbon oils: I make a practice of examining every sample of oil which comes in my way, and which may be included in this. I may say that when Fontenelle and Chateau wrote the hydrocarbon oils were far off the important position they now occupy.

Mr. Allen says that I think "the chemists who have devised methods of determining glycerin deserve no recognition of their labours. I simply contradict this assumption. Mr. Allen "challenges Mr. Warren to show that Chevreul indicated any such thing; but if he did," &c. It is a pity Mr. Allen cannot be logical; either Chevreul did what I say or he did not. Will Mr. Allen say that fixity of composition is a myth?

Mr. Allen seems to think that smart remarks are as good as argument. I wish to say that they do not add to the dignity of a scientific discussion, even when they are showered by a man in Mr. Allen's position upon one like myself. I have no interest in oils whatever; I have simply taken their study up, *inter alia*, as a pastime amusement: still I should be sorry if I had to admit that Mr. Allen was my intellectual superior in this matter.

Mr. Allen's ten methods show how little we have to boast about for twenty-one years. Is it not a fact that consumers of oil are more disgracefully imposed upon now than they have ever been before? Omitting those relating to butter, the remaining eight methods have done no very important part in protecting a consumer.

I omitted to mention in the proper place that Chateau's "antiquated" work is given in the list published, about a month ago, as a work of reference for the technical examination in oils, by the City and Guilds of London Institute. I am so far impressed with the usefulness of this book that I have applied for permission to translate the same. I am waiting for a reply.

Accompanying this letter are extracts from Chateau and Fontenelle which Mr. Allen has asked for, and which are referred to in this letter.—I am, &c.,

THOMAS T. P. BRUCE WARREN.

Tamworth Villa, Earlham Grove,
Forest Gate.

[We have sent the extracts from Chateau and Fontenelle to Mr. Allen. The discussion, having ceased to be of general scientific interest, must now close.—ED. *C. N.*]

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cv., No. 17, October 24, 1887.

On the Congelation of Ciders.—G. Lechartier.—Congelation at −18°, and maintained for 212 hours, did not sterilise worts and ciders in different stages of fermentation, although the fermentation was enfeebled. The application of a temperature of −18° to −20° does not give a saccharine solution containing ferments the property of resisting further transformations if subsequently exposed to ordinary temperatures.

Action of Hydrogen Sulphide upon the Salts of Cobalt.— H. Baubigny. — The author showed some years ago that all the salts of nickel are converted into sulphides if their solutions are treated with hydrogen sulphide at the ordinary temperature, and if heated even in an acid liquid. On studying the salts of cobalt in the same manner he has arrived at similar results, the only sensible difference between the two metals consisting in the less or greater readiness with which their salts are converted into sulphides. The appearance of the sulphide is much more rapid in the solution of a neutral salt of cobalt than in the corresponding salt of nickel, all things being equal. In cold, acetic acid can completely annul the action of hydrogen sulphide upon both cobalt and nickel sulphates.

Determination of Titanic Acid.—Lucien Lévy.—In certain cases the ordinary method gives good results, but according as more or less sulphuric acid has been volatilised, and as the substance is more or less rich in bases, considerable errors may be produced. The liquid should first be completely neutralised, and the required quantity of sulphuric acid (0·5 per cent) should then be added. After fusing the sample with bisulphate the solution of the melted mass is always slow. It may be hastened by adding sulphuric acid enough to convert all the potassa into the state of bisulphate. When the whole is dissolved the author adds 0·5 per cent of free sulphuric acid, boils for six hours, collects, washes, ignites, and weighs the titanic acid.

Moniteur Scientifique, Quesneville.
Series 4, Vol. i., August, 1887.

Analysis of Commercial Manures.—From the *Proceedings of the Association of Agricultural Chemists* at Washington. Given in the CHEMICAL NEWS for October 29, 1886.

Manufacture of Methyl Violet (Paris Violet).—Dr. Otto Muhlhauser. — A full account of the manufacture of this colouring-matter by the recent phenol process.

Manufacture of the Orangés.—Dr. Otto Muhlhauser. —An account of the preparation of sulphanilic acid, of orangés II., I., RR, and R.

Chemical Composition of Herderite and Beryl.—S. Penfield and D. Harper. — Translated from the CHEMICAL NEWS.

Manufacture of Potassium Chlorate on the Magnesium Process. — By Longuet Higgins. — From the *Journal of the Society of Chemical Industry*.

On a Fundamental Law of Thermo-Chemistry.—Clarence A. Seyler. — Translated from the CHEMICAL NEWS.

On a Fundamental Law of Thermo-Chemistry.—A. Seyler and S. Pickering.— Translations of two letters addressed to the CHEMICAL NEWS.

Contributions to the Assay of Quinine.—O. Hesse. —From the *Pharmaceut. Zeiting*. This important paper does not admit of useful abstraction.

On Varnish Resins.— P. L. Simmonds.— From the *Journal of the Society of Arts*.

Industrial Review and Patents taken at Berlin.—Process for preparing barium carbonate from the sulphate by means of sugar or treacle. Dr. Wackenroder. W, No. 4513.

Process for preparing and separating a new α-naphthylamine-disulphonic acid. Dahl and Co., of Barmen. D, No. 2748.

Preparation of naphthol-trisulphonic acids, and of dioxy-naphthaline-disulphonic acid. F. Bayer and Co. F., No. 3046.

Preparation of quinoleine-parasulphonic acid. Baden Aniline Co. B, No. 7469.

Azo-colouring-matters derived from tetrazo-diphenyl-dicarbonic acid, or from its methylic or ethylic ethers. Dr. L. Paul. P., No. 3052.

Preparation of acetone. H. de Grousilliers. G, No. 4012.

Preparation of substituted naphthylene diamines; colouring-matters obtained with these combinations and with the nitroso-derivatives of the tertiary aromatic amines. Durand and Huguenin. D, No. 2764.

Preparation of brown colouring-matters by the action of nitrous acids or the nitrites upon the phenol-monosulphonic acids. H. J. Walder. W, No. 4596.

Preparation of acetyl or benzoyl chlorides by means of benzyl acetate or ethyl benzoate. Dr. E. Sellig. S, No. 3627.

Transformation of the pigment of santal-wood and other woods containing santaline into a soluble colouring-matter. Dr. Alb. Zander, Z. No. 848.

Oxy-azo colouring-matters obtained by combining diazo-amido-derivatives with phenols or phenol-sulphonic acids. B. Fischer and H. Michaelis. M., No. 4835.

Colouring-matters prepared with naphthylamine-disulphonic acid III. Dahl and Co. D, No. 2772.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Manufacture of Oxygen.—I have seen an article about the Brin process of manufacturing oxygen. Can you give me the address of the firm, or insert a question to that effect?—F.C.S.

MEETINGS FOR THE WEEK.

THURSDAY, 17th.—The Parkes Museum of Hygiene, 5. "The Importance of Open Spaces," by the Rt. Hon. the Earl of Meath.

— Chemical, 8. "On the Halogen Substituted Derivatives of Benzalmalonic Acid," by Chas. M. Stuart, M.A.

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American Exhibition closed October 31st,

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THE CHEMICAL NEWS.

Vol. LVI. No. 1460.

ON THE CONSTITUTION OF BASIC SALTS.

By SPENCER U. PICKERING, M.A.,
Professor of Chemistry at Bedford College.

I have previously drawn attention to certain analogies between basic and hydrated salts, and have attempted to explain these analogies on the theory of residual affinity (Chemical News, lii., 240, and liv., 216; *Chem. Soc. Proc.*, 1885, 122; and pamphlet on "Atomic Valency," p. 5).

The analogy goes further, I believe, than in the existence of definite basic salts comparable with definite hydrated salts. The solution of a salt contains, according to my views, hydrates of a higher order and more complicated than those which are generally known to exist in the solid state, and which, owing to their complexity and to their being always more or less dissociated, generally appear under our imperfect methods of investigation to be indefinite in composition, and to vary continuously with a variation in the physical conditions of the liquid (Chemical News, liv., 216). Anyone who has investigated basic salts must have been struck with the fact that, besides the existence of perfectly definite compounds, we also have basic compounds which are apparently indefinite in composition, but which we cannot accept as mere mixtures, and which, according to my views, are precisely analogous to the complex hydrates constituting a solution of a salt in water.

It was with the object of obtaining positive proof that the basic salts of variable composition are not mere mixtures, but are actual compounds, that the present investigation was undertaken. The results, as far as they go, are in favour of this view, but they are not sufficiently pronounced to afford a proof of it, and I venture to give them only in outline, more as an indication of the direction in which light on this subject might be obtained than as evidence for or against my views.

The definite basic sulphates of copper, though more numerous than those of iron or aluminium, are, as far as we know at present, only three in number (Chemical News, xlv., 121, and xlvii., 181; *Chem. Soc. Trans.*, 1880, 807). Their formulæ are $6CuO,2SO_3,5H_2O$, containing 74·787 per cent of CuO on the anhydrous substance, and $4CuO,SO_3,4H_2O$, containing 79·798 per cent CuO.*

When an ammoniacal solution of copper sulphate is diluted with water there is at first precipitated a violet-blue basic salt, having the composition—

$$4CuO,SO_3,2NH_3,5H_2O,$$

which in the proportion of CuO to SO_3 is 79·818 to 20·192 (*Chem. Soc. Trans.*, 1883, 336). With a larger amount of water the proportion of this basic ammoniacal sulphate decreases, and the precipitate finally contains no ammonia, and in appearance is totally different from the ammoniacal one, being light blue and flocculent, and easily distinguishable from any particles of the ammoniacal sulphate which may have come down with it. As the proportion of water is still further increased the precipitate becomes darker, more bulky, and at the same time more basic, the limits of basicity reached in any of my experiments being 94·4 per cent, reckoned on the anhydrous salt, a percentage which would correspond to the composition $17CuO,SO_3$. As this precipitate is already highly basic, and as, no doubt, still more basic ones might be obtained by using a larger proportion of water, it is reasonable to conclude that, if the precipitates are mixtures at all, they are mixtures of a basic sulphate with copper hydrate itself, and not mixtures of a less basic sulphate with a very highly basic one, the most basic definite sulphate known being only $4CuO,SO_3$.

The question to be answered, then, was—Can these precipitates be proved to contain, or not to contain, free copper hydrate? The answer was sought as follows:—Various precipitates of different basicity were prepared, and, after being dried under precisely similar conditions, were analysed. Now, if the higher basicity of one precipitate over another is due to the presence of excess of free copper hydrate, then, by subtracting the weights of the various constituents of the less basic one from those of the more basic one, we shall obtain the weight and composition of the copper hydrate ($xCuO+yH_2O$) which the second precipitate has in excess of the first, and so on with the other still more basic precipitates; and if the composition of this copper hydrate is found to be constant throughout the series, it may well be concluded that it is in reality excess of this same substance which causes the increase in basicity, whereas, if the composition of the copper hydrate thus calculated is different in each case, the hypothesis that the increased basicity is due to admixture of excess of this same substance (the copper hydrate) becomes untenable.

The experiments were complicated by the facts that the basic precipitates are very bulky and difficult to wash, that they are slowly decomposed by water, that they absorb carbon dioxide very readily, and that they take a very long time in becoming anhydrous. A series of experiments performed in 1882 were rendered useless by the absorption of carbon dioxide, the precipitates having been allowed to dry in the air.

In the present series the temperature of the water used for the dilution was 14·6, the liquid after twenty-four hours was syphoned off, and the precipitates were washed in a centrifugal wire-gauze drum lined with filter-paper; they were then dried *in vacuo* on porous tiles, and subsequently powdered and exposed each in two separate watch-glasses *in vacuo* till constant in weight, each watch-glass containing about 1 grm. As the drying occupied some months considerable variations in the temperature occurred, but, by removing the duplicate watch-glasses at different periods, it was found that these variations had no effect on the composition of the substance.

Although many precautions were adopted to exclude carbon dioxide during the sundry operations, a certain amount was nevertheless absorbed, and this was determined by distillation with acid *in vacuo* and measuring the gas evolved. It amounted to 0·96 to 2·3 per cent in the various cases, and a correction was applied to the analyses assuming that its absorption took place according to the equation—

$$xCuO,SO_3,yH_2O+zCO_2=z(2CuO,CO_2,2H_2O)+ \\ +H_2SO_4+y-(2z+1)H_2O,$$

it having been established by a separate experiment that copper carbonate prepared in the same way possessed the composition $2CuO,CO_2,2H_2O$ when dried *in vacuo*.

In the case of the less basic precipitates the ammonia present was determined before the carbon dioxide by boiling *in vacuo* with potash, and Nesslerising the ammonia evolved: the precipitates 2 and 3 alone contained any appreciable quantity; it amounted to 0·37 and 0·15 per cent in the two cases respectively. The sulphuric acid and copper oxide were determined gravimetrically, dividing the contents of each watch-glass into two or three portions for this purpose. This part of the analytical work was conducted by Mr. P. G. Sanford.

The final mean results obtained are given in the accompanying table, calculated to show the various amounts of CuO and H_2O present with a uniform weight—0·1 grm.—of SO_3. The individual analyses and duplicate experiments were all very fairly concordant, but it will be seen there is a want of uniformity in these final results.

* These formulæ apply to the salts when dried in air or *in vacuo*. At a high temperature Shenstone obtained the salt $6CuO,2SO_3,4H_2O$ (*Chem. Soc. Trans.*, 1885, 375).

The basicity of the precipitate increases generally with the proportion of water used for the precipitation, but those two which contained ammonia—Nos. 2 and 3—are exceptions to this rule; so also is No. 5, which approaches so nearly in composition to No. 6 that I have combined these two experiments in one mean.

Composition of the Precipitate obtained.

Molecules of water added to 1 molecule CuO in the sol. taken.	SO_3.	CuO.	H_2O.	Total.	$\frac{CuO}{CuO+SO_3}$.
1. 2,360	0·1	0·6733	0·2454	1·0187	87·067
2. 1,590	0·1	0·7353	0·1917	1·0270	88·025
3. 1,380	0·1	0·7760	0·2155	1·0915	88·584
4. 14,300	0·1	0·8821	0·2883	1·2704	89·812
5. 4,800	0·1	0·9585	0·3027	1·3612	90·550
6. 19,050	0·1	0·9536	0·2910	1·3446	90·507
Mean of 5 & 6	0·1	0·9561	0·2968	1·3529	90·528
7. 38,050	0·1	0·9955	0·3358	1·4261	90·831

Now, subtracting the weights of the various constituents of one precipitate from those of that next to it in basicity, we get—

Experiment.	CuO.	H_2O.	$\frac{H_2O}{CuO+H_2O}$.
4—1	0·2088	0·0429	17
5 and 6—4	0·074	0·0085	11
7—5 and 6	0·394	0·039	50

and, including those precipitates which contained admixed ammonio-sulphate,—

3—2	0·0407	0·0238	37
4—3	0·1061	0·0628	37

Thus in all cases except one—namely Expt. 1 as compared with 2—an increase in the amount of copper oxide is accompanied by an increase in that of the water. But the numbers certainly do not tend to show that there is any definite relationship between the excess of copper oxide and water such as would exist if the increased basicity were due to the admixture of varying amounts of copper hydrate; at the same time it cannot be pretended that the results are sufficiently numerous, regular, or concordant to give a satisfactory denial to such a view.

It must be remarked, however, that the proportion of water to copper oxide — 50 per cent representing $CuO,4{\cdot}4H_2O$, and 37 per cent representing $CuO,2{\cdot}6H_2O$— is considerably in excess of that retained by copper hydrate *in vacuo*, which certainly does not exceed $2H_2O$ and is probably not more than H_2O, and renders it improbable that the copper oxide is present in this form. The appearance and behaviour of the precipitates are also not favourable to the hypothesis of their containing free copper hydrate, since the less basic ones are rather compact, of a light opaque blue colour, and can be washed and dried without the slightest blackening, while their behaviour with carbon dioxide does not favour the supposition of their containing any of the known definite basic sulphates: these latter are attacked but slowly by the gas, whereas the precipitates in question are very easily attacked; thus in one experiment it was found that only 1-30th of some $4CuO,SO_3,2H_2O$, precipitated by potash, had been converted in twenty-four hours into carbonate by the passage of a current of carbon dioxide through water in which it had been suspended, whereas an equal weight of a precipitate corresponding in composition to No. 4 in the above table had, after similar treatment, been converted into carbonate to the extent of 80 per cent.

Nickel Mordants; their Use in Calico-printing and Dyeing.—L. Liechti and G. Ulrich (from *Chemische Industrie*).—The use of nickel mordants is recommended when it is desired to produce light but fast tones.

IODIDE OF STARCH.

By H. B. STOCKS.

Besides the ordinary method of formation (*i.e.*, by adding a solution of iodine to starch paste) iodide of starch is gradually formed when dry starch and an alcoholic solution of iodine are triturated in a mortar, provided the alcohol contains water. With absolute alcohol a brown colour is produced which, on the addition of water, changes to blue; it appears, therefore, that water is necessary to the formation of iodide of starch.

Iodide of starch is not formed when iodine vapour is passed over dry starch, but by using moist starch the iodide is formed; this also seems to show that water is necessary for the formation of this body.

It is formed by the action of various reagents on a mixture of potassium iodide and starch paste; the reagents are those which liberate iodine from its compounds—chlorine, bromine, nitric acid, strong sulphuric acid, ferric chloride, ozone (Schönbein), potassium permanganate—potassium bichromate, &c., produce the blue colour.

The blue colour produced by chlorine and by bromine is destroyed by excess of the reagents; excess of nitric acid or of sulphuric acid also destroys the compound.

In a paper by F. Mylius (*Ber.*, xx., 688, abstracted in *Journal Soc. Chem. Industry*) it is stated that the author has found that the formation of blue iodide of starch is not due to iodine alone, but also to the simultaneous action of hydriodic acid or an iodine salt. After reviewing the experiments that have been done, and repeating those of the author, I come to the conclusion that this is not the case. The statements made by Mylius are (1) That a solution of iodine in water does not give a blue colour with starch; this is manifestly incorrect, because iodide of starch is formed under these circumstances. (2) That "all the iodine solutions which colour starch blue contain hydriodic acid or an iodine salt." This may be answered in the same way, iodide of starch being formed when a solution of pure iodine is mixed with starch paste, or when iodine vapour is passed over moist starch. (3) "If a compound be present which destroys hydriodic acid—*e.g.*, chlorine—no blue iodine starch is formed." With regard to this statement Miller says that chlorine destroys iodide of starch owing to the formation of chloride of iodine. This I think much more correct than the above. The real fact is that a limited amount of chlorine, added to a mixture of hydriodic acid or an iodide and starch paste, colours it blue, owing to liberation of iodine, but excess of chlorine destroys the colour. It may be that chlorine takes the place of iodine in the compound with starch, as a compound with bromine is known. (4) "A silver solution decolourises iodine starch; on the addition of iodine, the mixture becomes yellow, but hydriodic acid or one of its salts restores the blue colour." Repeating this experiment it was found that on adding silver nitrate to a solution of iodide of starch, the blue was destroyed, with formation of iodide of silver; on adding excess of iodine to this the blue was reformed: if, however, without adding more iodine, hydriodic acid or one of its salts certainly produced a blue colour; but this is simply explained when we take into account the action of nitric acid. I have not been able to find in books to which I have access what action iodine has on a solution of silver nitrate, but I believe that a portion of nitric acid is liberated, and this acts on hydriodic acid or its salt, liberating iodine, and thus we get the blue colour.

I have stated the above in a concise manner, so as to show upon what grounds Mylius bases his idea that hydriodic acid or an iodine salt is necessary to the formation of iodide of starch.

Iodide of starch is soluble in a large quantity of pure water. As ordinarily prepared, it is an opaque blue mass, and when examined under the microscope is seen to consist of blue flocculent masses of the iodide floating in a liquid portion.

This shows that the idea of Liebig and others, that the colour of iodide of starch was due to the starch granules being mechanically coloured by iodine being deposited on their surface, was not correct, as in the above case the granules were entirely broken up.

On examining starch granules coloured by iodine, it appeared as if the whole of the interior of each granule were coloured; the iodine evidently has penetrated through the coating of starch cellulose into the inner portion which consists of real starch.

The chief peculiarity of iodide of starch is the readiness with which the colour is destroyed by heat; the change is gradual, the liquid becoming first greenish, then yellowish, and finally colourless. If, after boiling the iodide of starch until colourless, it be allowed to cool, the blue is not re-formed. Pellétier states that the blue colour is re-formed on cooling provided all the iodine has not been driven off by the boiling. If the heating is stopped at the yellowish stage, and the liquid allowed to cool, the blue is re formed to a slight extent, more so if only the greenish stage has been reached, but neither regain the original intensity of colour, showing loss of iodine. During the heating the smell of iodine was noticed in the escaping vapour.

With regard to the decolourisation of iodide of starch by heat, Baudrimont says that it is due to the volatilisation of the iodine, and states that it does not occur in sealed tubes, when concentrated iodide of starch is used, or when the liquid contains excess of iodine. He also states that dilute iodide of starch, heated in a sealed tube thirty or forty times was decolourised each time, and regained its blue colour on cooling. Kraut states that iodide of starch becomes colourless when heated in a sealed tube for some hours.

It was found that a solution of iodide of starch, when heated in a sealed tube, became colourless in an hour, and did not regain its blue colour on cooling; a solution containing much more iodine than the last required three days heating before it was decolourised, and it remained colourless on cooling. It is evident, therefore, that when iodide of starch is decolourised by heat, iodine is not necessarily volatilised, as stated by Baudrimont, and that his solutions were not heated long enough, or they would have been decolourised. Langlois states the same, that a concentrated solution of iodide of starch was not decolourised on boiling. The same remark may be applied here, namely, that the solution was not heated long enough, or it would have become colourless, as a very strong solution I tried, though requiring much boiling, eventually became colourless.

The decolourised iodide still contains iodine in some form. It seems then that the iodine goes into combination as some colourless body, as no free iodine is present in the boiled solution; this is evidently the case, as blues containing much iodine take a longer time to decolourise than those only containing a small quantity, or, in other words, time is required for the decomposition of the iodide of starch and formation of the new body. This is stated to be hydriodic acid by Kraut; Pelletier and Fritzsche say it contains no free hydriodic acid; Langlois says it contains iodic acid My experiments confirm those of Kraut. The starch is apparently not altered, for on adding more iodine to the decolourised liquid the blue was again formed, and this decolourisation and recolouration may be continued a number of times without any effect upon the starch. In open vessels only part of the iodine is converted into hydriodic acid, the rest being volatilised; in sealed tubes, however, all the iodine is converted into hydriodic acid.

If we now refer to the trituration of an alcoholic solution of iodine with dry starch, we shall find that the iodide was not formed; this is mentioned by Pohl, who says that the alcohol overcomes the attraction of starch for iodine, but on adding water the iodide is formed, owing to its weakening the effect of the alcohol.

If absolute alcohol be added to a solution of iodide of starch it is thrown out of solution, but the alcohol has no action upon it. I think, therefore, that the reason why iodide of starch was not formed in the above case is because of the absence of water, which seems to be necessary to its formation (see action of other reagents below).

With regard to the action of other reagents on iodide of starch. Sunlight decolourises it, as stated by Raspail, Guibort, and by Payen; a tube of iodide I exposed to diffused sunlight required about nine months to decolourise it. I expect the action of sunlight is similar to that of heat, only much slower, but have not yet examined the product, as my first tube was destroyed; however, I have another experiment in progress with a parallel tube kept in darkness.

Iodide of starch is precipitated from its solution by dilute hydrochloric, sulphuric, and nitric acids, strong hydrochloric acid, and by solutions of salts which do not act upon it, such as sodium chloride, barium chloride, &c.

Starch solutions are not precipitated by dilute acids as the iodide is. Strong nitric acid and strong sulphuric acid decompose the iodide.

Acetic acid does not precipitate the blue compound.

The blue compound is destroyed by chlorine (Henry and Humbert), by bromine (as before stated), by sulphurous acid, by hydrosulphuric acid (Langlois), arsenious acid (Pisani), alkalies, &c. According to Pisani the blue is destroyed by trichloride of antimony, chloride of arsenic, auric chloride, ferrous, manganous, mercurous, mercuric, and silver salts.

It is stated by Payen and Langlois that alcohol and ether abstract a part of the iodine from iodide of starch, but I did not find this to be the case, unless an excess of iodine is present, as a solution of iodide of starch treated with ether gave iodine up at first, but on repeated treatment with ether it still remained blue, but gave no iodine. A solution treated with alcohol gave up no iodine.

Starch has, therefore, more affinity for iodine than has alcohol or ether, or any other solvent for iodine I have yet tried. A solution of iodine in carbon bisulphide or benzene, when treated with starch paste, lost all its iodine, it combining with the starch; and oppositely carbon bisulphide or benzene do not extract any iodine from iodide of starch, when it contains no excess of iodine.

Therefore I think we are justified in regarding iodide of starch as a compound, or probably more than one compound of starch with iodine, water also being taken into account, and refer its decolourisation by heat to the fact that the iodine contained in it is converted into hydriodic acid.

Many analyses have been made of iodide of starch and formulæ proposed, but as the figures are so widely different it will be necessary to estimate the amount of iodine in iodide of starch prepared in different ways; I have not yet made any analyses of iodide of starch, but intend to do so if circumstances permit.

As the blue colour produced by the action of iodine on starch is of an interesting nature, I may mention as a sequel the few other cases in which a blue colour is produced by addition of iodine to organic substances.

1. A blue colour is produced when iodine is added to a solution of Iceland moss or Carragheen moss; this is due to the substance called lichenin, which is similar to starch in its composition and properties.

2. By the action of sulphuric acid on cellulose a body is produced which is blued by iodine.

3. In a paper by Frank E. Lott (*Journ. Soc. Chem. Ind.*, 495, 1887), in a description of Fritz's butyl bacillus, he says:—"The contents of the cells are partly coloured by iodine of a violet approaching black, either the whole contents or single isolated patches of it (two or three) or sometimes only one spot, I might add that the reaction with iodine does not take place at all stages of the growth of this organism. It depends, also, to a great extent, on the nourishing medium."

It is most probable that in the last two cases it was really starch that gave the blue colour.

THE METHODS EMPLOYED IN THE ANALYSIS OF IRON ORES.

TOGETHER WITH A

SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID.*

By A. A. BLAIR.

(Continued from p. 205).

Copper, Lead, Arsenic, and Antimony.

TEN grms. of the very finely-ground ore were treated with HCl, with the addition $KClO_3$, until only the siliceous residue remained unacted upon. It was then diluted, filtered, reduced with ammonic sulphite, all the excess of SO_2 was boiled off, and H_2S was passed through to saturation. The precipitate was allowed to settle in a warm place, and when the smell of H_2S had nearly passed off it was filtered on the pump, washed, and treated on the filter with KHS, to dissolve out the sulphides of arsenic and antimony. The filter containing the sulphides of copper and lead was dried and ignited in a porcelain crucible. The ignited sulphides were transferred to a small beaker and treated with HCl and HNO_3, excess of H_2SO_4 added, and the whole was evaporated down until SO_3 began to volatilise. Water was then added, and if any $PbSO_4$ separated out, an equal bulk of alcohol, and the whole was allowed to stand some hours, when the $PbSO_4$ was filtered off, dissolved in basic ammonic tartrate or acetate, and the PbS, precipitated by H_2S, was filtered, washed, and ignited. It was treated in the crucible (porcelain) with HNO_3 and H_2SO_4, and

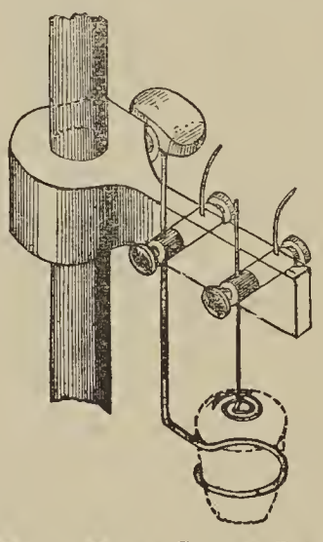


FIG. 9.—APPARATUS FOR COPPER DETERMINATION.

finally ignited and weighed as $PbSO_4$, which, multiplied by 0·6832, gave Pb. The solution containing the copper was evaporated down to drive off the alcohol, washed out into a platinum crucible, and the copper was precipitated on the crucible by the battery in the apparatus shown in Fig. 9, washed with water and alcohol, and weighed as Cu.

The KHS solution, containing the sulphides of arsenic and antimony, was acidulated with HCl and allowed to stand in a warm place until the sulphides and free sulphur had collected, and the solution smelled but faintly of H_2S. It was then filtered on the felt, and the precipitate, if it contained much free sulphur, was treated with carbon disulphide, transferred with the felt to a small beaker and treated with HCl and $KClO_3$, or aqua regia, which dissolved the arsenic and antimony very readily.

A little tartaric acid was added to keep the Sb in solution, the whole was diluted and filtered, excess of NH_4HO was added, and then magnesium mixture, and the arsenic precipitated as ammonic-magnesic arsenate, with the same precautions that were used in the precipitation of P_2O_5. The precipitate was filtered on the felt, washed with dilute NH_4HO, dried at 100° C., and weighed as $Mg_2(NH_4)_2As_2O_8H_2O$.

It was then heated, very gradually at first, and finally to a full red, and weighed as $Mg_2As_2O_7$. The first weight obtained, multiplied by 0·3947, and the second by 0·4839, gave As. If the heat was applied carefully and slowly enough at first the latter result was most apt to be the correct one. The filtrate which contained the antimony was acidulated with HCl and the Sb was precipitated by H_2S with the usual precautions, filtered on a small disk of paper on the bottom of the perforated crucible, dried, and the precipitate and paper were treated in a porcelain crucible with fuming nitric acid, evaporated to dryness, ignited, and weighed as Sb_2O_4, which, multiplied by 0·7922, gave Sb.

Titanic Acid.

As titantic acid was found to interfere with the determination of phosphoric acid, so the latter was found in many cases to absolutely prevent the precipitation of the former. When the ore contained only a small amount of TiO_2, 5 grms. were treated with HCl, evaporated to dryness, re-dissolved in dilute HCl, filtered, the insoluble residue dried, ignited, and treated in the crucible with HFl and H_2SO_4. The solution in the crucible was evaporated down until all the HFl and H_2SO_4 were driven off, ignited, and the residue was fused with Na_2CO_3. The fused mass was treated with hot water, which dissolved the sodic phosphate, aluminate, and excess of sodic carbonate,* leaving insoluble the sodic titanate and any ferric oxide, calcic carbonate, baric carbonate, &c. The insoluble portion was filtered off, washed, dried, and put aside to be added to the TiO_2 in the soluble portion. The filtrate obtained after the first treatment of the ore with HCl, which contained the great mass of the iron, with the TiO_2, which, dissolved with it, was deoxidised by ammonic sulphite, the excess of SO_2 driven off, and the ferric phosphate, titanate, and small excess of ferric oxide were precipitated by ammonic acetate exactly as in the estimation of the P_2O_5. This precipitate was filtered off, washed, dried, and fused with Na_2CO_3, the fused mass was treated with water, filtered, and the insoluble portion, containing Fe_2O_3 and sodic titanate, was washed and dried. The two filters containing the sodic titanate were separated as carefully as possible from the adhering precipitates, ignited in a platinum crucible, the precipitates were added, and the whole was fused at a low heat with 15—20 times the weight of acid potassic sulphate. The heat was gradually increased to a dull red and kept at this point until the fusion was perfectly clear and of a reddish brown colour. It was then cooled and treated with a large excess of cold water containing a few drops of H_2SO_4, with constant stirring until nothing remained undissolved except, perhaps, a little SiO_2. It was then filtered, washed with cold water, the filtrate was diluted to about 500 c.c., and boiled in a large platinum dish or beaker, with the constant addition of strong aqueous solution of sulphurous acid until all the TiO_2 was precipitated. The precipitate was allowed to settle, the clear solution was decanted through a filter, the precipitate was boiled up with water, thrown on the filter, and washed with boiling water, dried, ignited cautiously, and weighed as TiO_2. The filtrate was boiled again with the addition of sulphurous acid, and any further precipitate filtered off and added to the first. It was found that when the solution was kept at the boiling point during the filtration, and the precipitate washed with boiling water, there was no tendency to pass the filter; whereas if the solution was allowed to get cold, the filtrate was nearly always cloudy. To prevent the precipitation of ferric oxide with the TiO_2, it was necessary to keep an excess of SO_2 in the

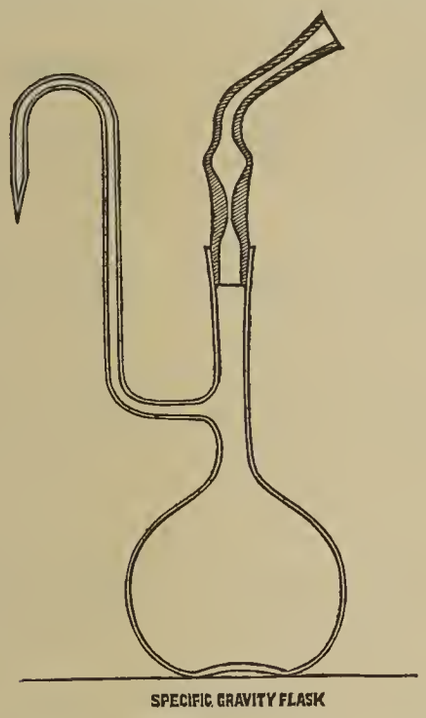
* From "Mining Industries of the United States."

* Any tungsten in the ore would be in this solution as sodic tungstate.

solution; but if, in spite of this precaution, the ignited TiO_2 was coloured with Fe_2O_3, it was fused again with $KHSO_4$ and re-precipitated. In the analysis of ores containing much TiO_2 it was preferable to fuse the ore at once with Na_2CO_3, treat with water, filter, wash and dry the residue, separate and burn the filter, fuse the residue and filter-ash with $KHSO_4$, and determined the TiO_2 as before.

Determination of Specific Gravity.

A great many experiments were made both on lumps and on powdered ore, and it was decided that in commercial samples good results could be obtained only by using the powdered material. The work was done, and the flask herein described was made by Mr. James Hogarth. About 20 grms. of the powdered sample were weighed out and transferred to the specific gravity flask, the construction of which is shown in Fig. 10. This flask was made with the view of overcoming two difficulties which occur in using the common flask, viz., the expansion and



SPECIFIC GRAVITY FLASK

FIG. 10.

overflow consequent on transferring the flask at 60° F. to the higher temperature of the balance-case, and the necessity for waiting until the finely divided mineral had settled before the stopper could be inserted without loss of material. These ends were successfully met by melting on a capillary tubulus to the lower part of the neck and grinding in a stopper having a small bulb above the capillary, to allow for expansion.

Having transferred the weighed quantity of ore to the flask enough water was added to cover it, and the temperature was raised almost to the boiling point by placing the flask in a water-bath. To insure complete expulsion of air the flask was now placed under a bell-jar connected with the aspirator and allowed to boil for a few moments at the reduced pressure. It was then filled up with water almost to the tubulus, cooled, the stopper was inserted, and by suction it was filled up slightly above the mark on the capillary part of the stopper. When the thermometer was stationary at 60° F. the volume was adjusted by touching the capillary end of the tubulus with blotting-paper, or by bringing a drop of water to it, as the case might require. The flask was then dried, transferred to the balance-case, and, after a sufficient time had elapsed to allow it to take the temperature of the room, weighed.

If W be the weight of ore taken, W′ the weight of ore + water at 60°, and K the weight of the flask + water at 60°, then

$$\text{Sp. gr.} = \frac{W}{W + K - W'}.$$

To obtain K the flask was nearly filled with boiled water and treated exactly as described above.

(To be continued).

REPORT OF THE COMMITTEE OF THE BRITISH ASSOCIATION*

APPOINTED FOR THE PURPOSE OF INVESTIGATING THE

INFLUENCE OF SILICON ON THE PROPERTIES OF STEEL.

WHEN the above Committee were appointed at the last meeting of the Association, a series of experiments had already been commenced, and a preliminary notice of these appeared in the Report for last year. This series of experiments has been completed, and full details have been published (*Jour. Chem. Soc.*, 1887, p. 129). A second set of observations in continuation of the work has also been commenced, and the results are so far advanced that it is hoped to publish details in a few months.

In the paper in the *Journal of the Chemical Society* a short account is given of the results hitherto obtained by other observers, and it is believed that the present state of our knowledge may be summarised as follows:—

1. Ingot iron. Silicon promotes soundness; it resembles carbon in increasing the tenacity and hardness; it should not exceed 0·15 per cent if the metal has to be rolled; and in some cases it produces brittleness when cold.

2. In steel castings. Silicon promotes soundness; it is, however, regarded as a necessary evil, and excess should be avoided, as tending to brittleness and low extension: about 0·3 per cent is generally recommended.

3. In crucible steel. A few hundredths per cent is necessary to produce soundness; it is generally agreed that considerable quantities of silicon may be present without injury to the material.

4. Manganese appears to be capable of neutralising the ill effect due to silicon.

The first series of experiments was undertaken to determine the effect of silicon on the properties of specially pure iron. For this purpose molten iron was taken from the Bessemer converter at the end of the "blow" and before any addition of ferro-manganese had been made. This was mixed in a crucible with various proportions of melted cast-iron containing about 10 per cent of silicon, and the product was afterwards examined. The composition of these materials was as follows:—

	C.	Si.	S.	Mn.	P.
Bessemer Iron	0·02	0·0098	0·039	0·06	0·04
Silicon Pig	1·96	10·30	0·02	1·90	0·17

In Table A is given a general summary of the results obtained. The mechanical tests were conducted by Professor A. B. W. Kennedy, and duplicate experiments gave concordant results. The mean values deduced from these experiments are given in Table B. The letter D is used to indicate that in these cases it is doubtful if thorough mixture was obtained. Other ingots were prepared containing more silicon, but as these could not be rolled no mechanical tests were performed.

The relative hardness was determined, as in my experiments on cast-iron, by means of the weight in grms. necessary to produce a scratch with a diamond on drawing its point over the smooth surface of the metal. The following list will illustrate the values obtained on applying such a method of examination to various substances. On comparing the values given in Table B it will be seen that the relative hardness was not very greatly influenced by the proportion of silicon added.

* Consisting of Profs. Tilden and W. Chandler Roberts-Austen and Mr. T. Turner (Secretary). Drawn up by Mr. T. Turner.

TABLE A.—*General Summary of Results.*

No.	Chemical analysis. (By Mr. J. P. Walton). C.	Si.	S.	Mn.	P.	Hot tests.	Cold tests.	Welding tests.	Specific extension. e_t	e_c	Modulus of elasticity. E	E_c
1.	0·02	0·0098	0·039	0·06	0·04	Worked well at welding heat; red short at dull red heat.	Good.	Perfect weld.	0·317	0·314	31,590,000	31,870,000
	—	—	—	—	—	—	—	—	—	—	—	—
2.	0·029	0·02	0·03	0·10	0·03	Do.	Do.	Broke owing to red shortness.	0·326	0·329	30,640,000	30,420,000
	—	—	—	—	—	—	—	—	—	—	—	—
3.	0·02	0·027	0·028	0·07	0·042	Do.	Do.	Very good weld.	0·321	0·321	31,120,000	31,120,000
	—	—	—	—	—	—	—	—	—	—	—	—
4.	0·076	0·035	0·03	0·10	0·06	Do.	Do.	Do.	0·328	0·320	30,530,000	31,250,000
	—	—	—	—	—	—	—	—	—	—	—	—
5.	0·057	0·039	0·03	0·09	0·05	Do.	Do.	Do.	0·330	0·321	30,300,000	31,120,000
	—	—	—	—	—	—	—	—	—	—	—	—
6.	0·052	0·08	0·036	0·09	0·06	Do.	Do.	Do.	0·311	0·323	32,130,000	31,000,000
	—	—	—	—	—	—	—	—	—	—	—	—
7.	0·113	0·117	0·015	0·08	0·045	Do.	Do.	Do.	0·333	0·326	30,070,000	30,640,000
	—	—	—	—	—	—	—	—	—	—	—	—
8.	0·034	0·113	0·033	0·09	0·08	Do.	Do.	Not so good.	0·312	0·313	32,100,000	32,000,000
	—	—	—	—	—	—	—	—	—	—	—	—

Substances.	Relative hardness.
Steatite	1
Lead (commercial)	1
Tin	2·5
Rock salt	4
Zinc (pure annealed)	6
Copper (pure annealed)	8
Calcite	12
Softest iron	15
Fluor-spar	19
Mild steel	21
Tyre steel	20—24
Good cast-iron	21—24
Bar-iron	24
Apatite	34
Hard cast-iron scrap	36
Window-glass	60
Good razor steel	60
Very hard white iron	72

The following are the general conclusions arrived at from this series of experiments. On adding silicon, in the form of silicon pig, to the purest Bessemer iron, the following results are obtained :—

The metal is quiet in the mould when even a few hundredths per cent of silicon is added. The metal is originally red-short, especially at a dull red heat, though it works well at a welding temperature; the red-shortness is increased by silicon. In all cases examined, the metal was tough cold, and welded well, silicon having little or no influence. Silicon increases the elastic limit and tensile strength, but diminishes the elongation and the contraction of area, a few hundredths per cent having a remarkable influence in this respect. The appearance on fracture by tensile force is changed from finely silky to crystalline, while the fracture produced by a blow gradually becomes more like that of tool steel as silicon increases. The hardness increases with the increase of silicon, but appears to be closely connected with the tenacity. With 0·4 per cent of silicon and 0·2 per cent of carbon, a steel

General Summary of Results (continued).

Limit of elasticity per sq. in.		Breaking load per sq. in.		Ratio of limit to break.	Extension p.c. on 10 in.	Reduction of area per cent.	Relative hardness.	Remarks.
Pounds.	Tons.	Pounds.	Tons.					
28,600	12·77	48,850	21·80	0·586	24·7	76·3	18	Silky.
29,680	13·25	48,810	21·79	0·608	30·7	77·8	—	Very finely silky.
30,000	13·39	46,410	20·72	0·646	19·5	43·4	16	Fracture irregular; about 60 per cent silky; the remainder in patches and pipes of crystal.
28,610	12·77	42,940	19·17	0·666	15·7	37·3	—	Very unsound and faulty; irregular crystalline spots; surface extremely distressed all over.
36,530	16·30	49,040	21·89	0·744	24·2	63·7	15	Fracture silky, but full of pipes and reedy holes in part filled with crystalline siliceous matter; some small specks of crystal.
42,980	19·19	48,410	21·61	0·888	27·8	71·1	—	Very finely silky, but with three large and about 20 small round pipes, filled with siliceous matter, which flew out in a cloud of dust on fracture; surface reedy.
33,860	15·11	51,920	23·18	0·652	15·6	30·0	17	Fracture irregular, with unsound pipes or fissures; mostly crystalline granular; edges silky.
36,470	16·28	51,430	22·96	0·709	17·1	33·7	—	Like No. 6, but more irregular, and surface a good deal distressed.
34,090	15·22	50·640	22·60	0·673	15·4	36·3	17	Fracture irregular and not entirely sound; about 30 per cent finely crystalline, rest silky.
39,490	17·63	53·670	23·97	0·735	21·1	39·1	—	Irregular; mostly silky, but with crystalline spots, in places unsound and reedy; surface reedy.
40,160	17·92	54,280	24·23	0 739	24·0	46·0	20	Silky, but with irregular crystalline specks and pipes.
34,780	15·53	52,050	23·24	0·668	24·5	43·8	—	Silky but irregular, with crystalline spots and pipes; surface a little distressed.
39,730	17·73	61,490	27·45	0·646	12·8	19·7	21	Fracture 65 per cent finely crystalline, the rest half finely granular; half silky; surface very much distressed on one side.
40,920	18·27	64,180	28·65	0·638	18·4	33·9	—	Fracture about 65 per cent finely crystalline, the rest irregular, for the most part silky; surface a good deal distressed.
41,620	18·58	57,720	25·77	0·721	22.0	47·7	20	Silky; specked with crystals and silica (yellowish crystalline material), a little reedy on surface.
40,710	18·17	57,330	25·59	0·710	17·7	36·2	—	Somewhat irregular, silky—with flattened pipes containing crystalline siliceous matter; surface a little distressed.

Table B.—*Mean Results of Tensile Tests.* Professor Kennedy.

No.	Si p.c. found.	Limit of elasticity. Tons per sq. in.	Breaking load. Tons per sq. in.	Ratio limit to break.	Extension per cent on 10 inches.	Reduction of area per cent.	Relative hardness.
1	0·0098	13·01	21·80	0·597	27·7	77·0	18
2	0·02	13·08	19·95	0·656	17·6	40·3	16
D 3	0·027	17·75	21·75	0·861	26·0	67·4	15
4	0·035	15·69	23·07	0 680	16·3	31·8	17
5	0·039	16·42	23·28	0·704	18·2	37·7	17
6	0·08	16·72	23·77	0·704	24·2	44·9	20
7	0·117	18·00	28·05	0·642	15·6	26·8	21
D 8	0·13	18·37	25·68	0·715	18·8	41·9	20

was obtained difficult to work at high temperatures, but tough when cold, capable of being hardened in water, and giving a cutting edge which succesfully resisted considerable hard usage. In some cases silicon was present in the oxidised condition; the effect is then very different, and the mechanical properties of the metal more nearly resemble those of the original Bessemer iron.

In the second series of experiments various proportions of silicon have been added to ingot metal, containing manganese and carbon, as ordinarily met with in commerce.

The results are not yet quite ready for publication, but they show that manganese greatly modifies the effect of silicon in producing red-shortness, and hence enables the metal to be readily rolled and otherwise worked, even in presence of several tenths per cent of silicon. The low extension, however, though not nearly so marked as before, is still observed, despite the presence of manganese; and hence, for the majority of the applications of mild steel, silicon does not appear to be advantageous.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

November 12th, 1887.

Prof. W. E. AYRTON, F.R.S., Vice-President, in the Chair.

LIEUT. BACON, R.N., was elected a member of the Society.

Owing to the illness of Dr. Shettle the paper announced to be read by him was postponed.

The following communication was read:—

"*On a Geometrical Method of Determining the Conditions of Maximum Efficiency in the Transmission of Power by Alternating Currents.* By T. H. BLAKESLEY, M.A.

In this paper the author confines himself to the consideration of a simple circuit containing generating, conveying, and recipient parts, in which the E.M.F. follows the law of sines.

The maximum E.M.F. of both machines are supposed known, together with the resistance and coefficient of self-induction of the complete circuit.

The variable on which the efficiency of transmission depends is the difference of phase of generator and receiver. A geometrical construction is given by which the phase which gives maximum efficiency can be determined.

Mr. KAPP thought the construction would not apply apply where the receiver does mechanical work, owing to the E.M.F. not being a true sine function of the time. He also mentioned an experiment performed on a motor driven successively by alternating and direct currents, in which the *apparent* power—

$$\left(\sqrt{\overline{\varepsilon^2}}\ \sqrt{\overline{c^2}}\right)$$

supplied by alternating currents was about five times that required when direct currents were used, the motor giving out the same power in the two cases. From this he inferred that the ratio of power to weight is much greater for a direct than for an alternating current motor. This he considered a serious drawback to the use of alternate currents for transmitting power.

After some remarks by Prof AYRTON and Prof. S. P. THOMPSON, Mr. BLAKESLEY said that by placing a condenser between the terminals of the recipient machine a greater current could be passed through the receiver than that in the generator and line.

Prof. A. W. RÜCKER exhibited and described a Lecture experiment for determining the velocity of sound.

The principle of the arragement is that used by Fizeau in determining the velocity of light. A vibrating reed is used as the source of sound and a sensitive flame as receiver.

A long U-shaped tube has its two ends placed near and parallel to the plane of a perforated disc, which is capable of rotating about an axis perpendicular to its own plane. The reed and sensitive flame occupy similar positions on the opposite side of the disc.

On rotating the disc the sensitive flame flares or is quiescent, according as the time taken to travel the length of the tube is an even or an odd multiple of $\frac{T}{2n}$, where T is the time of one revolution and n the number of holes in the disc.

Mr. BOSANQUET exhibited a form of polariscope he had made some time ago for researches on the polarisation of the sky.

Its chief feature is a compound prism of right- and left-handed quartz, which shows coloured bands with polarised light whatever be the direction of the plane of polarisation. It also forms a very sensitive object for polarimeters.

NOTICES OF BOOKS.

*Milk: Chemical and Micro-biological Studies.** By E. DUCLAUX. Paris: J. B. Baillière et Fils.

THIS work is something more than a mere guide to the analysis of milk, its components, and its products. The author studies the constitution of this important secretion, and the changes which it as well as butter and cheese undergo, especially from the action of ferments. To all who wish to undertake its examination he recommends certain precautions not generally taken. The milk may be introduced at once into tubes, which are then sealed and heated to 115°. Or test-tubes are fitted with a plug of cotton-wool, moderately compact. These tubes are then sterilised by heating to 120° to 130°. The teat of the cow is carefully washed, and, after a little milk has been drawn to clear the dust, a sufficient quantity is drawn into the tube, which is held quite close to the teat, but not touching, the plug of cotton having been first removed with forceps. As soon as the tube is full the plug is returned to its place. On prolonged standing the milk separates into a number of strata, the fatty matter floating uppermost.

The first part of the book is occupied with the examination of butters. A general method is laid down for their analysis, the matters to be determined being water, fatty matter, common salt, volatile fatty acids (free and combined), milk-sugar, and fatty acids in the state of glycerides. In this last determination the author saponifies with potassa, but he disapproves of the simultaneous use of alcohol, as recommended by Hehner and Angell.

He then compares recent butters of known gravity with the more or less rancified butters of commerce. To understand the changes which the latter have undergone he studies the influence of three factors—oxygen, light, and microbia. As regards the latter, their effects upon the fatty matter of butter are blended with those sustained by the caseine present.

In the second part M. Duclaux takes up the study of caseine,—a very complicated question. He rejects the views of Danilewski and Radenhausen, who regard caseine as a complex of eight bodies; and he contends that even the albumen of milk, its caseine, and its lacto-proteine (albumen) are one and the same substance in different conditions of solution. An elaborate study of rennet is next to be found.

The various methods for the analysis of milk are considered at some length. The author sets aside as inexact the procedures of Hoppe-Seyler, of Millon, and Commaille. He notices also, briefly, the methods of Payen, Storch, and Ritthausen; but that of Mr. Wanklyn is entirely ignored.

Quevenne's lacto-densimeter, or as it is called in this country, lacto-meter, is fairly judged,—that is, condemned, M. Duclaux points out that the surface-tension of milk is different from that of a saline solution, and hence an instrument graduated according to the latter will give false results with milk. But he overlooks the fact that

* "Le Lait: Etudes Chimiques et Micro-biologiques."

all methods of judging the quality of milk by its specific gravity, however obtained, are deceptive. We have heard of samples of milk being condemned because they contained an unusual proportion of cream, and were consequently lighter than the normal standard. We thought that all chemists who undertake the analysis of articles of food must be aware that a dealer can lower the specific gravity of a sample of milk by skimming, and can then raise it to its original point by the judicious addition of wator. The creamometer and the lactoscope are likewise pronounced untrustworthy, but the lacto-butyrometer of Marchand is considered suitable for rough-and-ready testing.

The author's own method for the analysis of milk forms the subject of a special chapter. He determines the specific gravity and the ash, the milk-sugar, the dry residue (total solids), and the fatty matter, and the caseine (suspended and dissolved). He does not notice the method for the determination of fatty matter proposed by Mr. Adams, of Maidstone, which, we learn, is gaining favour in Germany. In determining the dry residue he condemns the addition of sand or other pulverulent matter, which he finds retards perfect desiccation, or even renders it impossible. He uses, instead, pieces of sponge about the size of a nut, which are first very carefully washed, then dried, and preserved in ether until wanted. He considers that these sponges, when saturated with the milk and dried, present the fatty matter in a very suitable state for extraction in ether.

Judging from his analysis asses' milk is ten times dearer than cows' milk, and is worth three times less. The question, however, remains whether it does not present nutritive matter in a state better suited for assimilation by the human digestive organs than is the milk of the cow. Its proportion of milk-sugar is much higher than in that of the cow or the goat, and approaches that of woman.

The remaining portion of the work discusses the manufacture of cheese, the process of ripening, the general method for the analysis of cheese, and the characteristics of some of the most esteemed kinds,—such as those of Cantal, Brie, Gruyère, and the Parmesan, those of Gorgonzola and Roquefort. Of foreign cheeses the author mentions those only of Parma and of Holland.

This book is well worth the attention of public analysts, agricultural chemists, and of intelligent manufacturers of cheeses.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
Vol. xlvii., No. 12, June 26, 1887.

Action of Selenious Acid upon Manganese Dioxide.—P. Laugier.—Selenious acid in solution attacks natural manganese dioxide very slightly, even after prolonged boiling. There is found a crystalline orange substance mixed with a large excess of undecomposed peroxide. Small quantities of manganous seleniate are found in solution. In sealed tubes at 140° the results are similar. Hydrated manganese dioxide is readily attacked, yielding a brown solution which decomposes almost spontaneously into an orange-yellow matter, and a manganous seleniate which remains in solution. It is a basic sesqui-manganese selenite.

Action of Acetylene upon Benzene in presence of Aluminium Chloride.—M. Raoul Varet and G. Vienne.—The principal products of the reaction are cinnamene, diphenyl-ethane, and dibenzyl.

On Two Isomeric Mono-nitro-Camphors, derived from Ordinary Camphor.—P. Cazeneuve.—Already noticed.

Supplementary Note on Chloro-nitro-Camphor β.—P. Cazeneuve.—Already noticed.

Influence of Temperature on the Speed of the Reaction of Marble with certain Mineral Acids.—W. Spring.—The speed of the reaction is approximately doubled on an increase of 20° of temperature.

Justig Liebig's Annalen der Chemie.
Vol. ccxxxix., Part 2.

Communications from the Chemical Institute of the University of Bonn.—These consist of papers on the anilides of fumaric and maleic acids, and on phenyl-asparagic acid, by R. Anschütz and Q. Wirtz, and on the isomerism of fumaric and maleic acids, by R. Anschütz.

Communications from the Chemical Laboratory of the University of Würzburg.—These communications comprise papers by Emil Fischer on the urea-derivatives of dibrom-pyruvic acid; by E. Fischer and O. Knœvenagel on the compounds of phenyl-hydrazine with acroleine, mesityl oxide, and allyl bromide; by Rich. Arheidt on diphenyl-dihydrazine; by A. Pfülf on hydrazine benzol-sulpho-acids; by the same author on certain indoles; by Jul. Raschen on indoles from the tolyl-hydrazines; by A. Schlieper on indoles from α-naphthyl-hydrazine; by Max. Wenzing on derivatives of the three methyl-indoles; and by E. Fischer on the hydrazines.

Notices on Zirconium.—O. Hinsberg.—The author has attempted to form zirconium ethyl, but finds that it is not capable of existing under the conditions of his experiments. He has obtained a zirconium hydrox-iodide $ZrI(OH)_3$. It is an amorphous colourless powder, which, on exposure to the air, turns brown and loses iodine. It is readily soluble in water. The author did not succeed in obtaining an iodide, ZrI_4.

Moniteur Scientifique, Quesneville.
Series 4, Vol. i., August, 1887.

Examination of the Leaves of Gymnema silvestre.—David Hooper.—This paper, evidently of English origin, is said to be taken from "*Journal Nature.*"

Action of Hydrofluoric Acid upon Silica and the Silicates.—J. B. Mackintosh.—From the *School of Mines Quarterly.*

Transparence of Cast-Iron.—W. Ramsay.—From the Chemical News.

Manufacture of Vinegar.—This memoir, taken from the *Journal Vinicole*, contains instructions for the conversion of alcohol into vinegar.

Detection of Fusel Oils.—The *Brennerei Zeitung* maintains that the evil flavour of potato-spirit depends less on the quantity of fusel oil present than on its quality. Grain spirit improves with age, which is not the case with potato-spirit.

Freezing-Mixtures.—F. Fol (from the *Chemiker Zeitung*).—The author has experimented on the reduction of temperature caused by mixtures of ethylic and methylic alcohol, and ether with snow. He finds that 100 parts of glycerin mixed with 300 parts of snow give a mixture at 20° (probably − 20). These experiments suggest a possible method for detecting the adulteration of extracts of dye-woods with syrup. The author finds that pure extract of chestnut (sp. gr. 1·210), mixed with an equal weight of snow, gave a temperature of 2°, whilst under the same circumstances an extract of chestnut of the same specific gravity, but adulterated with a solution of sugar, stood at 3·5°.

Hydrogen Peroxide in Brewing.—G. Reisenbichler.—Hydrogen peroxide serves in the first place to free the

water from living organisms. It also destroys in the wort the acid and mould ferments. In stronger doses it destroys the alcoholic ferment and stops fermentation.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Asphaltum.—Could you kindly inform me through your correspondence column of any work which contains the chemical composition of raw aspbaltum?—E. Price.

Destroying Fish.—Explosives, such as dynamite or gunpowder, are very effective by the shock. If preferred, bread soaked in a strong decoction of bruised *Cocculus indicus* (strained), may be strewn upon the water. Fish, on eating this, become stupefied, and are easily caught. Why not drag the lake?—G. A. Keyworth.

Manufacture of Oxygen.—Under "Notes and Queries" of your issue of the 11th inst. I notice an enquiry as to who are the manufacturers of oxygen under the Brin process. You are perhaps aware that this Company is the proprietor of the Brin processes.—T. N. Hester, Secretary, Brin's Oxygen Company, Limited, Connaught Mansions, Victoria Street, Westminster, S.W., Nov. 15, 1887.

MEETINGS FOR THE WEEK.

Monday, 21st.—Medical, 8.30.
Tuesday, 22nd.—Royal Medical and Chirurgical, 8.30.
—— Institution of Civil Engineers, 8.
Wednesday, 23rd.—Society of Arts, 8. "The Mercurial Air-pump," by Prof. Silvanus P. Thompson, D.Sc.
—— Geological, 8.
Thursday, 24th.—Royal, 4.30.
—— Telegraphic Engineers, 8.
Friday, 25th.—Quekett Club, 8.
Saturday, 26th.—Physical, 3. "On the Analogies of Influence Machines and Dynamos," by Prof. S. Thompson, D.Sc. "Effect produced on the Thermo-electrical Properties of Iron when under Stress or Strain by raising the Temperature to a Bright Red," by H. Tomlinson. "Optical properties of Phenyl-thiocarbimide," by H. G. Madan.

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BADISCHE ANILIN AND SODA FABRIC.

PATENTS FOR DYES AND COLOURING MATTERS.

NOTICE IS HEREBY GIVEN that on the 26th day of July, 1887, the Judgment of Mr. Justice Pearson in the Action of The Badische Anilin and Soda Fabrik *v.* Levinstein (High Court of Justice, Chancery Division, 1881 B., No. 5077), whereby the validity of the Letters Patent of 25th February, 1878, No. 786 (Red and Brown Dyes), was established, and an Injunction restraining the Defendants from infringing the said Letters Patent was granted to the Plaintiffs with the usual account of profits and other relief, was affirmed by the House of Lords, and the Defendants were ordered to pay to the Plaintiffs the costs incurred by them in the Courts below and also the costs incurred by them in respect to the Appeals to the House of Lords. All persons (not being Licensees of the Badische Anilin and Soda Fabrik) are hereby cautioned not to make, sell, or use, or import into the United Kingdom any Red or Brown Dyes or colouring-matters made according to the Invention comprised in the above-mentioned Letters Patent.

Dated this 11th day of November, 1887.

J. H. and J. Y. JOHNSON,
47, Lincoln's Inn Fields, London, W.C.,
Solicitors to the Badische Anilin and Soda Fabrik.

MR. J. S. MERRY,

ASSAYER AND ANALYTICAL CHEMIST
SWANSEA.

WILLIAM FOX, Analytical Chemist.

LABORATORY:
40, GREAT TOWER STREET, LONDON. E.C.
Analyses of Oils, Pigments, Varnishes, &c.

American Exhibition closed October 31st,

But, owing to the large number of orders now in, orders will be received and filled there till November 23rd.
(On account of the Holiday and unlimited work in Philadelphia this is the latest day orders can be filled).

PROF. A. E. FOOTE, of Philadelphia, would call attention to the short time remaining in which choice American Minerals can be had at low prices.

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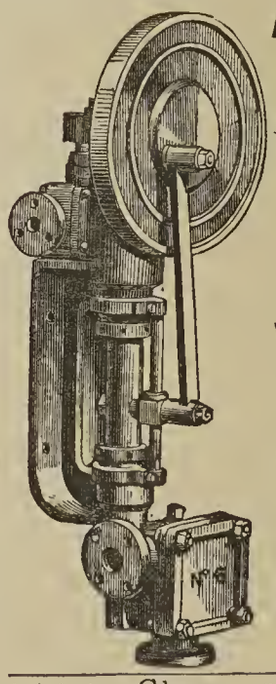

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THE CHEMICAL NEWS.

Vol. LVI. No. 1461.

SENSITIVENESS OF TASTE.

By F. P. VENABLES, Ph.D., F.C.S.

The recent experiments of Fischer and Penzoldt ("Ueber die Empfindlichkeit des Geruchsinnes," *Liebig's Annalen der Chemie*, ccxxxix., p. 131) have led me to search for some record of similar experiments determining the limits of the sense of taste. Finding none, an investigation was undertaken in which the following experiments were made.

The substances examined were weighed and then dissolved in known volumes of the appropriate solvent. This solvent was generally water, and water was always used in dilution, so that the taste was not interfered with by the solvent. To eliminate personal error two persons acted as tasters. In each case one cubic centimetre of the solution was tasted. The solutions were diluted to a point at which the taste was barely perceptible (in some cases perceptible to only one of the experimenters), and that was taken as the limit.

The results were as follows :—

Sugar.—3-1000ths of a grm. barely tasted.

Salt (NaCl).—1-1000th of a grm. barely tasted.

Tannin.—2-10,000ths tasted; 1-10,000 failed to taste.

Hydrochloric acid.—1-10,000th of a grm. barely tasted.

Saccharin.—5-1,000,000ths of a grm. barely tasted.

Strychnin.—5-10,000,000ths of a grm. barely tasted.

University of North Carolina, U.S.A.

THE ESTIMATION OF SILICON IN IRON AND STEEL.

By J. JAS. MORGAN.

Mr. Turner, in an article in the Chemical News, vol. lvi., p. 49, on "The Estimation of Silicon in Iron and Steel," states that it is extremely difficult to thoroughly remove the last trace of iron from the residue after evaporation of phosphoric irons with aqua regia, and gives results of some experiments which he has made to prove his statement.

This difficulty of obtaining a silica perfectly free from iron by the aqua regia method has been long known to metallurgical chemists, and was drawn attention to some ten or twelve years ago, in an article, either in the Chemical News, or the *Journal of the Chemical Society*, by Mr. Riley, who attributed it to an insoluble phosphide of iron.

Mr. Turner also states that "with phosphoric irons containing titanium, the silica is contaminated with titanium."

From this it is evident that Mr. Turner is ignorant of the fact, viz., that part of the titanium remains behind in combination with the silica, obtained by treating the iron with aqua regia, whatever the amount of phosphorus present, be it large or small.

It is found that if the evaporation of the solution, obtained by treating four grms. of the iron with aqua regia, be arrested upon its attaining a thick syrupy condition, so that it is with difficulty poured round the sides and bottom of the dish when given a circular movement, the silica obtained upon subsequent treatment with hydrochloric acid, washing three or four times with dilute hydrochloric acid, and twelve times with hot water, is white and free from phosphorus and iron, as was proved by fusion with acid potassium sulphate, when the percentage of silicon found agreed, within experimental error, with that originally obtained, and also by the filtrate being free from phosphorus and iron.

The author has made a large number of experiments with this modified process, and obtained results agreeing with the percentages of silicon calculated from the silica obtained by the usual method after fusion with acid potassium sulphate to purify.

The following are a few results.

	Methods.			
Exp.	Evap. to complete dryness, with subsequent fusion with pot. sulph. Silicon, p.c.	Mod. process. Silicon p.c.	Mod. process with subsequent fusion with pot. sulph. Silicon p.c.	Phos. p.c.
I.	0·932	0·932	0·932	0·860
II.	1·780	1·773	1·770	0·860
III.	0·587	0·563	0·560	0·936
IV.	0·705	0·700	0·701	0·854

THE INTERACTION OF ZINC AND SULPHURIC ACID.

By V. H. VELEY, M.A.

As unfortunately I was unable to be present at the meeting of the Chemical Society at which Messrs. Pattison Muir and Adie's paper was read and discussed, and as others, notably Mr. Spring, besides myself are engaged on parallel lines of research, I would venture to offer here a few remarks on the subject. It appears that Mr. Spring's results (*Ann. Chim. Phys.*, August, 1887), obtained by a measurement of the rate of evolution of hydrogen, do not adequately represent the rate of chemical change as comparable, for example, with the rate of evolution of gas from a homogeneous liquid; for it is to be noticed that, when a regular surface of metallic zinc is placed in sulphuric acid, the bubbles of hydrogen at first cling to the surface and gradually increase in size until they assume such dimensions that they overcome their cohesion with the surface. This may to some account form the phenomenon of initial retardation observed by Spring. Secondly, though the evolved bubbles of gas may to some extent remove the solution of zinc salt from the vicinity of the dissolving metal, yet if the liquid is carefully poured off it will readily be observed that that portion which has been immediately in contact with the metal is of a different specific gravity from the rest, is in fact a concentrated solution of the metallic salt. The hydrogen evolved is a resultant of a series of changes, each one of which is variable at any moment, such as the rate of diffusion of the salt of the metal in the acid liquid, the amount of surface exposed, which Spring kept approximately constant, and the local rise of temperature caused by the heat evolved. The amount of gases other than hydrogen, such as sulphurous oxide and hydrogen sulphide, are, doubtless, dependent upon the more or less perfect removal of the product of the change from the sphere of the dissolving metal as well as upon the concentration of the acid solution. On the other hand, it does not appear that variations in the relative masses of zinc would make any difference either in the rate of solution or in the products of the change were the surfaces exposed in all cases equal. The dissolution of a solid in a liquid cannot but be regarded as a superficial action only. For the present I would merely wish to mention that I am engaged in a research in which the rate of dissolution of metals in acids is being investigated under such conditions that not only fresh surfaces of a regular geometrical figure of metal are continuously being exposed, but also the products of the change, whether gas or metallic salt, are at once and continuously removed from the vicinity of dis-

solving metal; thus, the effect of local rise of temperature would also be reduced to a minimum.

University College, Oxford,
Nov. 14, 1887.

ON A NEW METHOD OF EXAMINING BUTTER.

By THOMAS T. P. BRUCE WARREN.

I INTENTIONALLY omit many preliminary points in connection with butter examination, although I do not ignore their value.

Ten grms. of the butter is carefully weighed and transferred to a tared filter-tube, plugged with asbestos, which has previously been well washed with carbon disulphide to remove any loose fragments of asbestos; the plugged tube is then carefully dried and weighed. About 100 c.c. of pure carbon disulphide, or more if required, are poured over the butter gradually and allowed to filter through, more disulphide is added, so as to remove every trace of fatty matter.

The filtrate is received in a tared porcelain basin, which is carefully evaporated over hot water; when every trace of solvent has been removed it is cooled and again weighed. The difference between this and the original weight is due to salt, caseine, water, extractive colouring-matter, which has been added, &c., insoluble in disulphide carbon.

The fatty matter is again dissolved in about its own volume of disulphide carbon, and the same volume of yellow chloride sulphur, diluted with an equal measure of disulphide carbon added with constant stirring. The disulphide is completely evaporated over hot water. This part of the process ensures the reaction of the chloride sulphur.

The resulting thickened mass should yield a perfectly clear solution with disulphide carbon. An insoluble residue will indicate the presence of any vegetable oil, notably those which are used in the manufacture of oleomargarine or butterine. In fact, it is absolutely impossible to add to or to substitute for butter any vegetable oil product with which I am at present acquainted.

The filter tube is carefully dried and then weighed; to the weight of the residuum in the tube is added the weight of the fat extracted; the loss from the original weight is that of the water. It is next treated with warm distilled water, which will dissolve out the salt and colouring-matter. According to the colour of the fat itself and quantity of colouring-matter, an insight may be gained as to what the original butter was when it left the churn, at least before being churned with "the chemicals." It does not, of necessity, point to adulteration, as colouring-matter is frequently added to improve the appearance of the real dairy product. The filter tube is finally washed out with dilute liq. ammonia, until every trace of caseine has been removed, which may be reprecipitated with hydrochloric acid, collected on a tared filter, dried, and weighed. Water is passed through the tube, which is then dried and weighed. Starch or any other foreign matter not previously removed can easily be detected.

In examining good samples of country butter in this way I have been struck with the large amounts of caseine present, in one sample obtained from a respectable family grocer, and for which 20d. per lb. was paid: I found 15 per cent caseine and about 85 per cent soluble fats, with traces of water, salt, and a yellowish colouring-matter.

I am not aware that caseine has been referred to by English chemists as an important adulterant of butter, but Chateau speaks of "lait durci au feu" as a source of fraud. I propose, on a future occasion, to examine this portion of the subject more minutely.

It seems to me that Chambers of Agriculture may well take this matter up, for if the mischief is produced by the real dairy farmer the sooner it is stopped the better. I am, however, inclined to think that we must look to another quarter for this fraud.

Many dairy farmers do not work up their own milk, but sell the same to some manufacturing firm, who manipulate the milk for the recovery of curd, &c. This is a fraud which does a great injustice to the dairy farmer and to the agricultural interest in particular, to say nothing of the consumer.

If we are to contend with the fraudulent sale of oleomargarine as butter, we must impress on those whose interest it concerns that there must be no tampering with the product yielded by good wholesome milk.

The *permissive character* of legislation on such subjects connected with adulterations has done more towards the depravity of our national candour than one cares to think about too much.

Animal fats, such as lard, lard oil, &c., behave very much like butter, and are so far capable of being blended with it, but the tests already in use amply provide against this source of fraud.

I may just say that the fearful frauds now practised with lard oil, and the addition of rosin or rosin oil in any form, and also petroleum, to any vegetable oil, are instantly detected by this method of testing.

Are our oil experts aware of the incentive to dishonesty which they hold out to an unscrupulous vendor. Chloride of sulphur has been recently condemned for this purpose of testing oils; I suppose it clashes too severely with the interest of the oil trade. I simply protest against any chemist using his position as an ægis for the questionable practice of others.

I am indebted to Mr. Edwin Bruce Warren for the experimental data on which this paper is founded. I hope to deal more fully with this subject, and to consider the influences, &c., which may modify this reaction.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING OCTOBER 31ST, 1887.

By WILLIAM CROOKES, F.R.S.;

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To GENERAL A. DE COURCY SCOTT, R.A.,
Water Examiner, Metropolis Water Act, 1871.

London, November 7th, 1887.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from October 1st to October 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The whole of the 182 samples examined were clear, bright, and well filtered.

The water-supply to the Metropolis has been characterised, for several months past, by the smallness of the

nearly always inconsiderable proportion of organic matter which it contains. Thus, during the months of July, August, and September, the mean proportion of organic carbon present in the Thames-derived supplies, was 0·136 part in 100,000 parts of the water, corresponding to appreciably less than one-quarter of a grain of organic matter per gallon, or to less than $\frac{1}{3000}$th part of 1 per cent.

The supply during the past month was found practically identical in character with that of the preceding three months. All the samples, alike from the Thames and the Lea, were free from turbidity, and unexceptionable in respect to colour; while the proportion of organic matter present was but small, and very uniformly so, in the different samples examined. Thus the maximum proportion of organic carbon in any one sample was 0·151 part in 100,000 parts of the water; while the mean proportion present in the Thames-derived supplies, *i.e.*, 0·137 part in 100,000 parts of the water, was identical with the mean for the previous three months. With the coming on of the rainy season, however, it is not to be expected that the present exceptional smallness of the proportion of organic matter, and degree of freedom from colour-tint, will continue.

We are, Sir,
Your obedient Servants,

William Crookes.
William Odling.
C. Meymott Tidy.

ON REMARKABLE RELATIONS BETWEEN THE SPECTRUM OF WATERY VAPOUR AND THE LINE SPECTRA OF HYDROGEN AND OXYGEN,

AND ON THE

Chemical Structure of the Two Latter Bodies and their Dissociation in the Atmosphere of the Sun.

By Professor A. GRUENWALD.

(Continued from p. 202).

From the weighty and remarkable relations and characteristic numerical data deduced, not from single rays but from a comparison of entire series of numerous rays of oxygen, watery vapour, and hydrogen, there follows, according to the fundamental theorem (I.) very simply the chemical structure of oxygen in the interval in which it emits the elementary line spectrum. Let H′, O′, *b*′, O″, *b*″, *c* be the substances which, in a combined state within oxygen, emit the above homonymous groups of rays (H′), (O′), (*b*′), (O″), (*b*″), and (*c*), and let [H′], [O′], [*b*′], [O″], [*b*″] and [*c*] be the volumes which they occupy in a volume-unit of oxygen. We have then the equations:—

$$[H'] = \tfrac{1}{8}, [O'] = \tfrac{1}{8};$$
$$[b'] + [O''] = [O'] = \tfrac{1}{2}$$

and according to theorem (I.) and with reference to the facts under 4β:

$$\tfrac{2}{3}\tfrac{3}{2}[b'] = \tfrac{5}{8}[O''] = \tfrac{2}{3}[O'] = \tfrac{1}{3}$$

whence—

$$[b'] : [O''] = 4 : 5$$

and—

$$[b'] = \tfrac{4}{9}[O'] = \tfrac{2}{9}[O''] = [O''] = \tfrac{5}{9}[O'] = \tfrac{5}{1\,8}.$$

Further—

$$\tfrac{5}{8}[O''] = \tfrac{5}{8} \times \tfrac{5}{1\,8} = \tfrac{2\,5}{1\,4\,4}$$

the space which O″ occupies in watery vapour within the oxygen; then—

$$[b''] + [c] = [O''] = \tfrac{5}{1\,8}$$

and according to theorem (I.), on account of the facts given under 4γ—

$$\tfrac{2}{3}\tfrac{1}{1}[b''] + \tfrac{3}{8}[c] = \tfrac{5}{8}[O''] = \tfrac{2\,5}{1\,4\,4},$$

whence again—

$$[b''] : [c] = 4 : 5,$$

and—

$$[b''] = \tfrac{4}{9}[O''] = \tfrac{4}{9} \times \tfrac{5}{1\,8} = \tfrac{1\,0}{8\,1}[c] = \tfrac{8}{9}[O''] = \tfrac{8\,0}{1\,4\,4}$$

The chemical structure of oxygen in the above-mentioned interval of temperature is consequently expressed by the chemical volume formulæ—

$$O = H'.O', \quad O' = b_4.O''_5, \quad O'' = b_4 c_5$$
$$O = H'.[b_4 O''_5] = H'.[b_4.(b_4 c_5)_5].$$

That is—

"Oxygen in its simplest molecular condition is a compound of the modified hydrogen, H′, which is emitted by the II.nd so-called compound line spectrum of hydrogen in equal volumes with a substance, O′, without condensation. The latter, O′, is a compound of four volumes of the pentavalent (nitrogenoid) element *b* of hydrogen in a peculiar state of chemical condensation with five volumes of a substance, O″, which again consists of four volumes of the primary element *b* (though in a chemical state different from the former), with five volumes of a new primary substance, *c*, as yet unknown.

As I have here ascertained in a mathematico-spectroscopic manner the chemical structure of H and C, I should also be in a position to determine the chemical structure of the so-called elements, nitrogen and carbon, by means of my chemical theory of perturbations if eminent spectroscopists had placed at my disposal complete and trustworthy lists of the wave-lengths of ammonia, NH_3, and methan, CH_4, at a low temperature of the electric spark (so as to avoid their dissociation) or the absorption spectra of these gases. These spectra must extend in the ultra-violet part far down to the respective wave-lengths 1728×10^{-7} and 1383×10^{-7} and possibly still lower.

As regards nitrogen, I have hitherto only succeeded in showing that it, in its simplest chemical condition, is (like oxygen) a compound of the "modified hydrogen H′, in equal volumes with a substance, N′, without condensation, and that the latter substance, N′, must have an entire large group of atoms in common with oxygen, since a proup of more than 40 N rays (*i.e.*, their wave-lengths) can be converted by multiplication with the factor $\frac{47}{46}$ into a group of corresponding O rays, that is their wave-lengths.

The volume-formula of nitrogen will very probably have the form of that of oxygen, but with lower indices, since the atomic weight of nitrogen (14) is smaller by 2 than that of O (16).

In carbon also I have been already able, by a mere comparison of its spectrum with the spectra of watery vapour, H and O, to ascertain the existence of the primary matter *b* in at least two different chemical conditions as well as the presence of the primary matter *c*, which is also contained in oxygen.

5. *α*. In the experiments which I instituted upon the spectrum of water to ascertain the reduction factor belonging to the body *α* in hydrogen (0·6336 or approximately $\frac{19}{30}$), I observed that this factor is indeed the mean or chief reduction factor of the four atoms in H which are combined with the substance *b*, but that also special factors for reduction to the water spectrum belonged to each of these four atoms. Of these I succeeded in detecting two, namely, $\frac{3}{4}$ and $\frac{56}{75}$, and in verifying them, at least in as far as the well-known spectrum of H_2O could be compared.

If, therefore, λ is the wave-length of a H-ray of the elementary line spectrum derived from a substance, *a*, in H, then 0·6336 λ (empirically $\frac{19}{30}$ λ), $\frac{3}{4}$ λ, and $\frac{56}{75}$ λ, are, with a near approximation, three different wave-lengths of the H_2O spectrum if the latter is sufficiently known.

β. If, on the other hand, λ is the wave-length of a H-ray emitted from a substance, *b*, existing in H in combination with *a*, then, according to 2, not merely $\frac{4}{5}$ λ must be a wave-length of the H_2O spectrum, but according to 4*β* (respectively 4γ) $\frac{46}{41}$ λ and $\frac{70}{59}$ λ must be two wave-lengths of the O spectrum. Further, $\frac{23}{32} \times \frac{46}{41}$ λ and

$\frac{21}{22} \times \frac{70}{69} \lambda$ must be two wave-lengths of the H_2O spectrum, and be capable of recognition, provided that the elementary oxygen spectrum is sufficiently well known, which is unfortunately not the case as regards very feeble rays.

With the above we come into possession of mathematico-spectroscopic criteria for hydrogen rays, which possess an evident similarity with chemical reactions for the detection and recognition of bodies.

(To be continued).

AIR-TIGHT TAPS.

By ARNOLD EILOART, B.Sc. (Lond).

Many forms of these taps were invented by me early in 1885, and several of them were exhibited in the Inventions' Exhibition that year; but as I find (*Chem. Soc. Journ.*, see below) that my earliest form, which is not the best, is still in use, it is necessary to say that the best form is that shown at Fig. I.

Here the plug of the tap has two grooves, G G, running round it, and is used with an ordinary socket, S. These grooves, filled with liquid, check transfer of gas between interior and exterior of tap, and if, through bad grinding, such transfer takes places, it is at once detected by bubbles in the liquid. They may be supplemented by vertical grooves joining them, in opposite quadrants of the plug-circumference, to stop passage of gas round the plug when the tap is turned off.

There was at first a little difficulty about filling the grooves: the outlets, A and B, of the tube, A B (see sketch), —or the vessels with which A B communicates—are closed. The finger closes C, and mercury moistened with glycerin

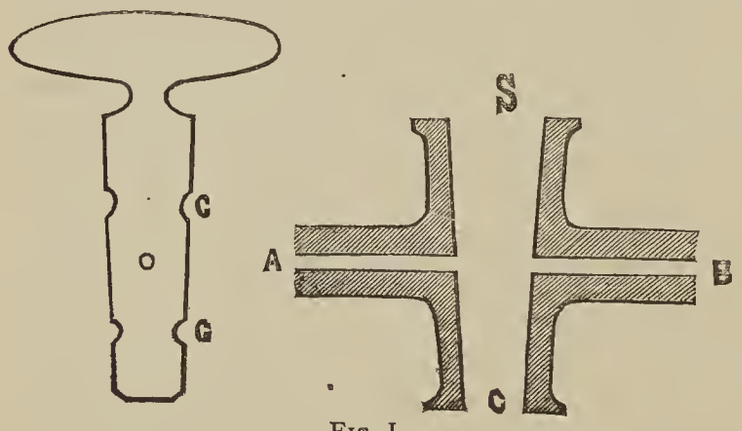

Fig. I.

is poured on to it; the plug is then put in, pushing the finger away; a little liquid runs towards A B, but very little, because there is no exit for the air in these tubes; so the liquid rises further and fills the upper groove as well as the lower.

The earlier form referred to above is shown at Fig. II. In this case the plug is an ordinary one, but the socket is closed below and cupped above to receive the liquid at C and C.

This was my first form, instructions for making samples of which I took to Mr. Cetti, and to which the following extract refers:—"The taps employed are those known in this country as Cetti's patent" (*Chem. Soc. Journ.*, ccxcvi., p. 611). (The text is accompanied by a diagram of Form II). But there can happily be no dispute about originality in this case, for I am assured that the attribution of the invention to Mr. Cetti will not now receive any public support from him, as a letter of his, following on representations by me, offers to place my initials on every tap, and to give me half the profits thereon, thus acknowledging in the most practical way its origination by me.

More important is the consideration of the relative merits of the forms I. and II. In form II. it will be seen that:—

(*a*) It can only be used in a position nearly vertical.

(*b*) If the plug "sticks" it cannot be tapped out from below.

(*c*) If too much liquid be placed in the socket below the plug the latter will not fit tightly if too little air remains.

(*d*) It is more expensive than I.

Adopting form I. any tap may be made air-tight for a few pence by grinding grooves in its plug.

For these reasons I have ventured to give the preference to form I. Samples of it were made for me by Mr. Hicks, Instrument Maker, Hatton Garden.

Leipzig, Nov., 1887.

ON THE EFFECTS PRODUCED BY SMALL QUANTITIES OF BISMUTH ON THE DUCTILITY OF SILVER.

By Surgeon-Major J. SCULLY, Assay Master, Calcutta

It is well known that alloys of silver and bismuth, in certain proportions, are brittle. In Dr. Percy's valuable work on Metallurgy (Silver and Gold—Part I.) it is stated that alloys of silver with bismuth, in the proportion of 50 per cent and 33 per cent of the latter metal, are brittle; while an ore of silver and bismuth, called Chilenite, in which bismuth occurs only to the extent of 14·4 to 15·3 per cent, is said to be malleable. The least amount of bismuth, however, which will injuriously affect the ductility of silver, for example, in such an operation

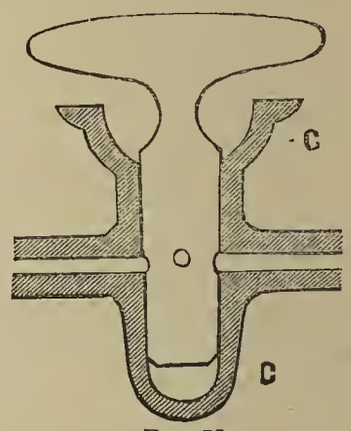

Fig. II.

as the lamination of silver bars for coinage, does not, so far as I am aware, appear to have been experimentally investigated. It may here be mentioned at the outset that an alloy of silver and bismuth may, by careful hammering, be extended considerably, so as to pass muster as malleable; although, if subjected to lamination by means of steel rolls, the same alloy will crack at the edges and thus show a deficient ductility, as compared with pure silver or some silver-copper alloys. It is to the deficiency in ductility, as tested by rolling, of silver containing only very small proportions of bismuth that I here wish to call attention.

My attention was first prominently directed, about two years ago, to the injurious effects caused by small quantities of bismuth in silver by the circumstance that some silver bullion, in the shape of English refined bars of as high a fineness as 990 per mille, proved so brittle as to be unfit for mintage. Attention was first attracted to this matter by the peculiar behaviour under assay of the granulated samples taken from this silver after melting. The appearances noticed under assay will be referred to presently, but they led to the bullion being at once tested

for brittleness. A bar, about 21 inches long, 2·25 broad, and 1 inch thick, was hammered out at one end without cracking, but on being passed through the rolls it cracked badly at the edges and was pronounced to be "brittle," in the Mint sense of the term. The bullion was then remelted in five plumbago pots, and a partial refinement of it attempted in the ordinary way with nitre, about 8 to 10 lbs. of this salt being used for each pot. The resulting silver bars were not appreciably improved by this treatment; hammering again proved an inconclusive test, but a bar of the size I have mentioned broke in two by merely dropping on the floor of the melting-room.

In the meantime the assay had shown that the brittle bullion contained bismuth, and that this was the only substance present likely to be the cause of brittleness. The Indian process of assaying silver has been described by Dr. Busteed in the *Journal of the Asiatic Society of Bengal* (1870, Part II., p. 377), and a brief abstract of this paper is given on p. 292 of Dr. Percy's work before mentioned. The main features of the process may here be briefly recapitulated for the purpose I have in view. A fixed weight of the silver bullion to be assayed is dissolved in an assay bottle, by means of nitric acid aided by heat; the solution is diluted with water and an *excess* of hydrochloric acid is added, to precipitate all the silver present as chloride. The silver chloride having been caused to aggregate and settle by vigorous shaking, the bottle is filled up with water, and the supernatant fluid is subsequently syphoned off, to remove all the now dissolved matter which may have been contained in the bullion. Under these conditions of solution, precipitation, and dilution with water, chemists will readily understand that even a small trace of bismuth, if it be in the silver, will reveal its presence by the partial formation of insoluble oxychloride of bismuth. Now, in the assay of the brittle bullion under consideration, solution in nitric acid had been readily and completely effected by the aid of heat; antimony and tin were consequently absent. After the addition of water and hydrochloric acid, however, the solution in the assay bottles could not be cleared by shaking; the bulk of the silver chloride collected at the bottom of the bottles, but the supernatant fluid remained turbid. Tin and antimony being excluded, only two metals could produce this result in the wet assay of silver, namely, mercury and bismuth. To determine which of these is the interfering metal it is only necessary to note the effect of solar light on the silver chloride formed; when mercury is present the silver chloride maintains its pure white colour unaltered, while in the presence of bismuth the chloride immediately acquires the well-known purple colour under the influence of daylight. Our assays, then, being turbid after precipitation and yet the silver chloride blackening readily under the influence of daylight, it was evident that bismuth was present. The turbidity produced was due to the partial formation of bismuth oxychloride; and this compound diffusing itself in its characteristic manner through the solution had broken up part of the silver salt into very fine powder, so that some hours had to elapse before the supernatant fluid cleared by the gradual subsidence of both bismuth oxychloride and the finely divided silver cloride. The assay was of course thus rendered unreliable, since the silver chloride to be weighed, and on which the calculation of the fineness rested, was contaminated with bismuth oxychloride. A cupellation assay of this bullion was at once had recourse to for ascertaining its fineness.

So far, then, this tender of silver bullion seemed to establish the following points:—

1. Silver bullion of as high fineness as 990 per mille is rendered unfit for coinage purposes by an amount of bismuth which, in this particular case, could not possibly have exceeded 1 *per cent*, and was probably less than that proportion.

2. Hammering a bar of silver bullion is not a good test for detecting brittleness, as far as mint purposes are concerned.

3. The toughening of silver bullion 990 fine, and containing only a small amount of bismuth, by the aid of nitre in plumbago melting-pots, is not readily effected.

4. The presence of a trace of bismuth in silver of high fineness is immediately detected in the ordinary course of assay by the Indian method, but this bismuth interferes with the perfect accuracy of the results obtained by that process.

A comprehensive research seemed therefore called for to elucidate the whole subject, and the necessity for this investigation has since been emphasized by the fact that silver bullion contaminated with bismuth has frequently found its way to the Mint since its first discovery here. The points to be investigated seemed naturally to group themselves under the following heads:—

I. Is our ordinary wet assay of silver susceptible of such easy modification as will enable us to obtain perfectly accurate results by it, in presence of bismuth, without having recourse to the confessedly less accurate assay by cupellation? And, how may small quantities of bismuth in silver be readily estimated with the despatch indispensable for mint operations?

II. What is the smallest amount of bismuth in silver that will render it unfit for coinage, when present in bars of the Indian standard fineness of 916·6? And, what is the amount of bismuth that may be tolerated in such bars without materially injuring their ductility?

III. How is silver bullion containing bismuth, which may be tendered to the Mint, to be dealt with, supposing that establishment accepts any metal that is brittle; and how is the presence of bismuth in refined bars to be accounted for?

I. As the purity of the bismuth to be used in the experiments now to be detailed was a matter of first importance, I may briefly mention the steps taken to ensure the purity of the metal. Refined bismuth was dissolved in nitric acid, precipitated as basic nitrate by diluting largely with distilled water, the nitrate digested in solution of caustic potash, and then well washed, dried, and reduced by heating with charcoal in a clay crucible. A series of synthetical assays, made by dissolving together pure silver and pure bismuth, the latter in the proportion of from 1 to 5 millièmes, showed that our ordinary process of assay, under such conditions, gave unreliable results, there being a surcharge, or higher report than should have been obtained, which varied from 0·7 to 2·7 mills., when the proportion of bismuth was from 3 to 5 millièmes. A modification in our process of assay was evidently required if it were to be used for determining the fineness of silver bullion containing bismuth; and the necessary steps to this end were, after repeated experiment, found to consist in adding the smallest possible amount of hydrochloric acid for the precipitation of the silver, and increasing the amount of nitric acid in which it was first dissolved. We use ordinarily for the precipitation of an assay pound of silver 5·4 c.c. of hydrochloric acid, of sp. gr. 1075; but 2·5 c.c. of acid of this strength suffices for the complete precipitation of an assay pound of even fine silver; so that we have here at once a means of diminishing the tendency of any bismuth in the silver to form insoluble oxychloride. If, in addition to diminishing the amount of hydrochloric acid, we added a considerable excess of nitric acid to the solution (which acid would not in any way interfere with the silver chloride formed), all risk of the partial formation of insoluble bismuth salts seemed removed. This in fact has proved to be the case, and the successful modified process for the assay of silver containing bismuth is as follows:—

The assay pound of silver bullion containing bismuth is dissolved in 5·5 c.c. of nitric acid, sp. gr. 1200, with the aid of heat, about 5 ounces of water are added, and then 10 c.c. of nitric acid, sp. gr. 1320. The silver is now precipitated by the addition of 2·5 c.c. of hydrochloric acid, and after vigorous shaking the supernatant fluid will be found perfectly clear, and it will remain so when the bottle is filled up with water, all the bismuth

present being in solution. Whenever samples of silver now show the presence of bismuth during the assay, a fresh set is taken up and worked by the modified process, the delay thus caused not amounting to more than a few minutes. It may be mentioned here that all our assays are reported to one-tenth of a millième (0·1 per mille).

Having thus ascertained the presence of bismuth in silver bullion, and put in practice a modification of the assay process which renders us indifferent to its presence, it is still of importance to ascertain the exact proportion of bismuth which is present in the bullion, and, to be of practical use for mint work, this determination must be effected rapidly and as simply as possible. The ordinary directions given for the separation of bismuth in the presence of silver, by first removing the latter as chloride and then precipitating the bismuth as carbonate, do not, I find, give accurate results when silver is present in such overwhelming proportions as obtain in the cases under consideration.

I have therefore adopted the following plan, which a number of synthetically prepared solutions have proved to give quick and good results, though sometimes the amount of bismuth present is very slightly underestimated. The ordinary silver assay having given a rough visual estimate of the amount of bismuth likely to be present, enough of the bullion is taken to yield a fairly weighable amount of bismuth oxide in the final result. The bullion is dissolved in a small amount of nitric acid, the solution carefully diluted, and an excess of ammonium carbonate at once added, the precipitation being aided by heating. The carbonates of silver and copper at first formed are re-dissolved, and the carbonate of bismuth after a time settles completely at the bottom of the beaker. The contents of the beaker are then passed through a filter, of which the weight of ash yielded by incineration is known, and the carbonate of bismuth on the filter washed quite free of all traces of silver. The filter is then dried, its contents transferred to a porcelain crucible for ignition, the filter-paper being ignited separately, treated with a drop or two of nitric acid to re-oxidise any bismuth oxide reduced by contact with the carbon of the filter, and the ash added to the crucible. From the weight of bismuth oxide thus found, after deducting the weight of the filter ash, the amount of metallic bismuth present in the sample of bullion taken for analysis can be at once found.

There are only two metals likely to interfere with accuracy of the process here described, namely, cadmium and lead; the carbonates of both these metals being as insoluble in excess of the precipitant employed as bismuth carbonate. Cadmium is very unlikely to be found in silver bullion and its consideration may be neglected, but if the presence of lead is suspected the carbonate filtered from the silver solution is dissolved in nitric acid, evaporated down with the addition of sulphuric acid, and the lead sulphate formed (if any) collected and weighed in the usual way. The bismuth is again precipitated as carbonate and treated as before directed. Many experiments have been made with synthetically prepared mixtures of silver, copper, lead, and bismuth, the latter two metals being in very small proportion to the silver, so as to imitate the composition of some refined bars. Ullgreen's plan for the separation of the carbonates of lead and bismuth, by dissolving them in acetic acid and then precipitating the bismuth by means of a lead rod, does not work satisfactorily and requires too long a time for the precipitation.

(To be continued).

Crystalline Glucose.— Seyberlick and Trampebach have obtained glucose in crystals after conversion by means of nitric acid and crystallisation from a slightly alkaline solution. — *Zeitschrift Zucker Industrie* and *Chemiker Zeitung*.

THE METHODS EMPLOYED IN THE ANALYSIS OF IRON ORES,

TOGETHER WITH A

SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID.*

By A. A. BLAIR.

(Continued from p. 215).

The Perforated Crucible.

IN processes in which the use of filter-paper is deleterious or inconvenient, filtrations and ignitions have been made with the aid of the asbestos filter devised by Mr. Gooch, which consists essentially of a felt of asbestos deposited upon perforated surface of platinum.†

The mode of preparing the filter is as follows:—Asbestos of fine, silky, flexible fibre is scraped longitudinally (not cut) to a fine, short down, which is purified by boiling in strong hydrochloric acid and washing by decantation. A platinum crucible, with bottom perforated with numerous fine holes, is fitted to the upturning end of a piece of soft rubber tubing, the other end of which is stretched over the top of a funnel, as shown in Fig. 11, and the neck of

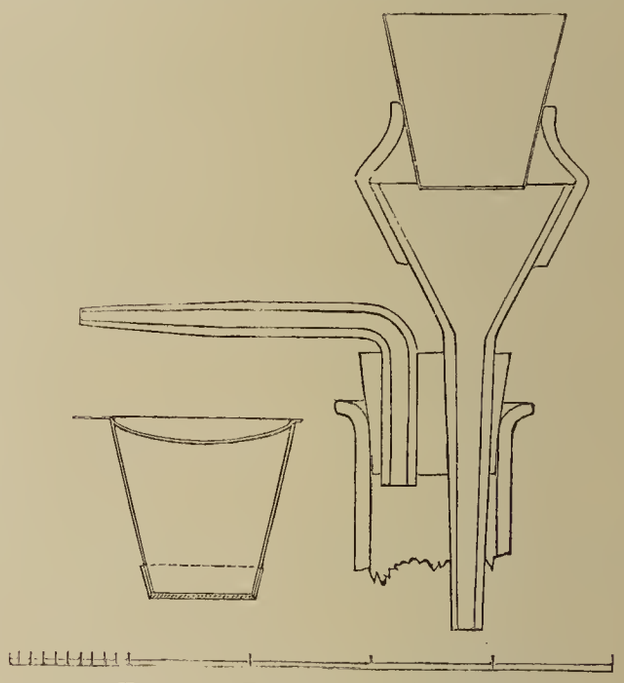

FIG. 11.—PERFORATED CRUCIBLE.

the latter passes through the stopper of a vacuum flask in the usual way.

The vacuum pump having been put in action, a little of the prepared asbestos, suspended in water, is poured into the crucible and the pump is attached, when the asbestos at once assumes the condition of a firm, compact layer, which is washed with ease under the pressure of the pump.

After washing the felt, the crucible with the felt adhering is removed from the funnel, ignited, cooled, and weighed as usual; then set again in place in the rubber holder, taking care that the pump is working, and the liquid to be filtered is poured into the crucible. The crucible, felt, and adhering precipitates are, after washing, ignited, or merely dried, as the case demands, with no further care than the nature of the precipitate itself necessitates.

During the ignition of precipitates, it is frequently necessary to prevent the contact of reducing gases with the perforated bottom; and this is accomplished by placing the crucible either upon a platinum crucible cover or

* From "Mining Industries of the United States."

† For a full description of the process, I refer to Mr. Gooch's original publication in *Proceedings of the Amer. Acad. of Science* (1878), or CHEM. NEWS, xxxvii., 181.

within a second crucible, or, better, by using a form of crucible which is conical in shape and provided with a cap, removable at pleasure, to cover the bottom during ignitions.* When a larger filtering surface than the bottom of a crucible affords is needed, a cone of platinum, perforated and fitted to a rubber seat, is substituted for the crucible.

Sketch of the Various Methods Proposed for the Determination of Phosphoric Acid, and Discussion of the Methods in General Use at the Present Time.

I shall not attempt in this sketch to trace those methods which are not applicable to iron ores, among which may be mentioned the lead, mercury (*Pogg. Ann.*, lxxvi., 218), uranium (Leconte, *Compt. Rend.*, xxix., 55), and tin (*Compt. Rend.*, xxxiii., 385) methods, and that based on the separation and weighing of ferric phosphate and the titration of the iron by solution of permanganate (Raewsky, *Compt. Rend.*, xxiv., 681).

The first step toward an accurate method for the estimation of phosphoric acid in presence of iron was taken when Otto (*Ann. d. Pharm.*, viii., 142, 167), in 1844, suggested its precipitation as $Mg_2(NH_4)_2P_2O_8$ by adding magnesic sulphate to an ammoniacal liquid in which the Fe_2O_3 was kept in solution by tartaric acid.

The separation of this acid from a large excess of ferric oxide was still very difficult, and the results obtained were very inaccurate.

In 1846 Svanberg and Struve (*Jour. für Pr. Chem.*, xliv., 291) discovered the reaction of phosphoric acid with ammonic molybdate, and Rose (*Pogg. Ann.*, lxxvi., 26) confirmed their statements. This, however, was only qualitative.

R. Weber (*Pogg. Ann.*, lxxiii., 137), in 1846, showed the necessity for converting any pyrophosphoric into orthophosphoric acid, and recommended heating with H_2SO_4 to accomplish this result.

About this time Fresenius (*Jour. für Pr. Chem.*, xlv., 258) published the method which is largely the same as that which is now known as the acetate method. It is in substance as follows:—Reduce the iron in the acid solution with Na_2SO_3 until Na_2CO_3 produces a white precipitate; boil off all SO_2, neutralise nearly with Na_2CO_3, add a few drops of chlorine water and excess of sodic acetate; add chlorine water until the liquid is red, boil until it clears, and filter hot. The precipitate contains all the P_2O_5. Dissolve this precipitate in HCl and precipitate the iron by NH_4HO and $(NH_4)_2S$, or precipitate, after reducing with Na_2SO_3, by NaHO, boiling hot, filter, and in the filtrate precipitate with magnesium mixture and ammonia.

He stated that neither citric acid nor sugar possessed any advantage over tartaric acid in preventing the precipitation of small amounts of iron with the $Mg_2(NH_4)_2P_2O_8$.

J. C. Nesbitt (*Jour. Chem. Soc.*, i., 44) claimed that the precipitate of $Mg_2(NH_4)_2P_2O_8$, from a solution containing $MgSO_4$, NH_4Cl, NH_4HO, Fe_2O_3, and Al_2O_3, contained varying amounts of Fe_2O_3 and Al_2O_3 unless the solution was very dilute and contained a great excess of tartaric acid and ammonia; and Fresenius (*Jour. Pr. Chem.*, xlv., 259) stated that at a certain degree of concentration a precipitate was thrown down from a solution containing only Mg_2SO_4, NH_4Cl, tartaric acid, and ammonia.

Rose, a little later, published an account of the various methods for the determination of P_2O_5, and said, among other things, in regard to the precipitate of—

$$Mg_2(NH_4)_2P_2O_8,$$

that the solution, after the addition of $MgSO_4$, NH_4Cl, and NH_4HO, should stand for some hours, and should not be heated above 30°.

The precipitate should be washed (according to Fresenius) with ammonia water, and the presence of a great excess of ammoniacal and other salts, Rose stated, had no influence upon the precipitation. He added that $(NH_4)_2CO_3$ threw down an insoluble double salt of Mg and NH_4, and should not be used instead of NH_4HO, and also that P_2O_5 could not be perfectly separated from iron by $(NH_4)_2S$, for while the FeS contained no P_2O_5, the filtrate deposited iron with the $Mg_2(NH_4)_2P_2O_8$. He also suggested the precipitation of P_2O_5 by $BaCO_3$.

Sonnenschein (*Jour. Pr. Chem.*, liii., 339) first used, about 1850, the molybdate method quantitatively. He used a solution containing 1 part ammonic molybdate and 20 parts HNO_3. Of this solution he used 30 times as much as was necessary to precipitate the P_2O_5, allowed it to stand several hours at a gentle heat, filtered, washed with the precipitant dissolved on the filter in NH_4HO, and then precipitated by Mg mixture.

Ullgren (*Jour. Pr. Chem.*, liii., 33), about the same time, proposed the following method:—A solution of the iron ore in HCl, or of the iron in HNO_3, evaporated to a syrupy consistency with HCl and diluted, was poured into a solution of potassic sulphide and potassic silicate (1 grm. of iron to 5 grms. potassic sulphide and 1 grm. potassic silicate). The precipitate contained MgO, CaO, Al_2O_3, and sulphides of positive metals; the filtrate, potassic phosphate, and sulphides of negative metals. The filtrate was mixed with freshly precipitated $PbCO_3$, filtered and washed with water containing one-tenth its volume of a concentrated solution of $(NH_4)_2CO_3$ and NH_4HO. The filtrate was evaporated to dryness, the mass moistened with HCl, diluted, and filtered from SiO_2. Filtrate contained P_2O_5 and traces of Fe_2O_3, &c. Tartaric acid was added, and P_2O_5 precipitated by Mg mixture as usual. He also suggested adding ferrocyanide of potassium and K_2S to the nitric acid solution of the iron containing tartaric acid, ammonia, and magnesic sulphate, filtering off the precipitate of S and $Mg_2(NH_4)_2P_2O_8$, and fusing with Na_2CO_3, and determining P_2O_5 in the filtered solution, after acidulating with HCl, by Mg mixture.

Kremers (*Pogg. Ann.*, lxxxiv., 77) gave the proper strength of ammonia water for washing the precipitate of $Mg_2(NH_4)_2P_2O_8$ as 3 parts water to 1 part NH_4HO. He said that the precipitate dissolved in all other mixtures.

W. Wicke (*Ann. Ch. Phar.*, xcv., 373) recommended molybdate of lead instead of molybdate of ammonia as a precipitant of P_2O_5.

W. Knop (*Chem. Centr.*, 1857, 691, and 861) stated that pure silicate of potash treated with HNO_3 and ammonic molybdate gave a precipitate similar to that obtained from a small amount of P_2O_5.

Damour and H. Sainte-Claire Deville (*Inst.*, 1858, 69), in 1858, showed that oxide of cerium added to an acid solution of P_2O_5 gave a pale yellow precipitate.

Staedeler (*Ann. Ch. Phar.*, cix., 306) recommended Otto's method, but suggested re-dissolving and re-precipitating the first precipitate of $Mg_2(NH_4)_2P_2O_8$.

A. Lipowitz (*Pogg. Ann.*, cix., 135) suggested the use of a molybdate solution containing 2 MoO_3, 1 tartaric acid, 15 water, 10 NH_4HO, and 15 HNO_3. After adding the precipitant to the solution of iron containing P_2O_5, he heated it to boiling, and weighed the precipitated phosphomolybdate of ammonia on a counterpoised filter, dried at 20° or 30°, or, better, over H_2SO_4. The precipitate contained 3·607 per cent P_2O_5.

H. Struve (*Jour. Pr. Chem.*, lxxix., 321) dissolved the iron in HNO_3 and HCl, evaporated to dryness, re-dissolved in HCl, and filtered from SiO_2, precipitated by NH_4HO, fused precipitate with Na_2CO_3, dissolved in hot water, filtered, and determined P_2O_5 in filtrate by Mg mixture.

V. Eggertz (*Jour. Pr. Chem.*, lxxix., 496), in 1860, recommended the molybdate method. He dissolved MoO_3 in 4 parts NH_4HO, and filtered into 15 parts HNO_3 (1·2 sp. gr.); dissolved the iron or steel in HNO_3, evaporated to dryness, re-dissolved in HCl, added molybdate solution, and set it aside at a temperature of 40°, with occasional stirring for 2 or 3 hours. He filtered the dried precipitate at 95°, and weighed. The precipitate contained 3·74 per cent P_2O_5.

(To be continued).

* This convenient little crucible is made and perforated in the best possible manner by J. Bishop, of Sugartown, Pa.

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, November 7, 1887.

Warren de la Rue, Esq., D.C.L., F.R.S., Manager and Vice-President, in the Chair.

The following gentlemen were elected Members:—Edmund Gosse, M.A., and F. H. Lewis.

The special thanks of the Members were returned to Mr. W. Resbury Few for his present of a large Photograph of the Nebulæ of Orion, the property of his late father, Mr. Charles Few.

The special thanks of the Members were returned to Mr. William Anderson for his present of a Double Acting High Vacuum Pump.

The special thanks of the Members were returned to the Rev. John Macnaught for his present of £50 for improvements in the Lecture Theatre.

The presents received since the last Meeting were laid on the table, and the thanks of the Members returned for the same.

NOTICES OF BOOKS.

Exercises in Quantitative Chemical Analysis: with a short Treatise on Gas Analysis. By W. Dittmar, LL.D., F.R.S., F.R.S.E. Glasgow: W. Hodge and Co.

Among the many chemical treatises for the use of students which have appeared within the last twenty years, the work before us may justly claim an exceptionally high rank. No one can say that its teachings, however correct, are mere reproductions of matter which have appeared again and again in previous works.

From the generality of laboratory text-books it differs by the exposition of quantitative electrolysis, a method which is coming more and more into use in the separation and the determination of metals. We find also instructions for the performance of Kjeldahl's method of determining nitrogen, of which, in these days, the student cannot well afford to remain ignorant. The processes of Schlœsing and of Walter Crum for determining nitric and nitrous acids are also described.

Perhaps the most important feature in the work is the section on gas analysis,—a series of methods now indispensable not merely in many departments of abstract research, but in technical chemistry. Without it the composition of chamber, furnace, and chimney gases could never be studied, and some of the most important industrial operations would be left in darkness.

In the separation of iron and alumina Dr. Dittmar recommends the caustic potash method. For separating nickel and cobalt the author mentions the processes of Liebig and Rose as now superseded, and describes the nitrite process (Stromeyer's), the nitroso-β naphthol method (of Ilinski and Knorre), and the Dirvell-Clark phosphate process—which he pronounces the most elegant of all the known separations of these two metals, but does not feel free to decide as to its relative exactness.

In the assay of iron and copper pyrites for sulphur he prefers the caustic potash method, which was worked out in his laboratory by Mr. John M'Arthur. He weighs out 5 grms. pure caustic potash, free from sulphate, and 3·5 grms. nitre, and melts them in 1 c.c. of water in a large basin, either of silver or—preferably—of Dittmar's alloy (91 Ag, 7 Au, and 2 Ni). He then places 0·5 grm. of the sample on the surface of the mixture, stirs up with a silver rod, and heats gently until the water is expelled and then to fusion, stirring constantly to prevent loss by spirting. He lets cool, dissolves in water, filters off iron oxide, washes in hot water until all alkali is removed, acidifies with HCl, boils for a few minutes, and adds excess of barium chloride. He points out a fact not universally known, that prolonged ignition of barium sulphate in a platinum crucible produces an appreciable quantity of barium sulphide.

For pyritic shales or coals he prefers Eschkas's method, which, however, if applied to ordinary pyrites, seems to give results from 1 to 2 per cent too low, so consequently inadmissible. He gives instructions for the determination of arsenic in pyrites. This used to be a somewhat sore point with alkali manufacturers. At least we have heard of one important firm who, in language more emphatic than courteous, interdicted their chemist from in future determining arsenic in samples of pyrites.

The latter part of the book contains promiscuous exercises in applied analysis, such as the analysis of sea water, of potash salts, of cast-iron, guano, milk, soap, tanning materials, &c.

We should fail to convey a fair idea of Dr. Dittmar's work if we made no reference to his peculiar point of view. This is conveyed in the second sentence of his instructions for weighing:—"But a mere knowledge of the method is not sufficient; you must practise the art for hours and hours until you have it at your finger-ends." This idea is generalised in the preface. The author says, meeting a supposed objection, "To some of my readers the tone of the earlier exercises more especially may savour a little of mechanical drilling. Why tell the student so minutely what he has to do, and hinder him from exercising his own ingenuity?" To this supposed objection he replies,—and in our opinion with great justice,—"Some ten years ago, if a book like the present had been placed before me, I should have asked this question myself. But I have since come to modify my views. The technicalities of quantitative analysis are the very things which the student is not likely to find out by himself. He had better be drilled into doing them correctly. . . . He must be made alive to the fact that no amount of scientific knowledge will enable a man to get through a qualitative analysis successfully unless he has the 'canning' as well as the knowing, and unless he attends to all those little practical details which to him at first sight may appear to be irrelevant." With these views we cannot but agree, and as the work is carried out accordingly we feel fully justified in giving it our hearty recommendation.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Moniteur Scientifique, Quesneville.
Series 4, Vol. i., July, 1887.

Determination of Phosphorus in Iron and Steel.—P. Vorwek.—From the *Chemiker Zeitung*.

Influence of Foreign Bodies upon the Properties of Refined Copper.—W. Stahl.—The author concludes that the spitting of copper is not produced in all cases solely by an escape of sulphurous gas, but sometimes also by the furnace gases which dissolve in the melted copper and escape at the moment of its solidification. Certain refined coppers, free from arsenic and lead, absorb gases, even before the reduction has been pushed to 0·07 and 0·05 per cent of oxygen, that is to the point where the metal acquires its maximum tenacity; these coppers, by reason of the porosity which results from the escape of gases at the moment of solidification, are much less fit

or mechanical uses than coppers which are denser, hough less pure. Small quantities of lead (about 0·25 per cent), of arsenic (0·4 per cent and even more), and in coppers free from lead and bismuth, traces of phosphorus act favourably upon the tenacity, the malleability, and the ductility of copper.

Use of Oxalic Acid in Qualitative and Quantitative Analysis.—C. Luckow.—This memoir, which is from the *Chemiker Zeitung*, will be inserted at some length.

Determination of Organic Substances in Water.—Dr. A. Koebrich.—This paper also will be inserted at length.

Detection of Traces of Aldehyd in Alcohols.—For the detection of aldehyd in alcohol or spirits they are reduced by distillation so as to concentrate the aldehyd in about one-fifth of the original volume. The product is passed into a capsule of porcelain, the white bottom of which renders coloured reactions more perceptible. There is then poured under it, through a funnel, the orifice of which rests upon the bottom of the capsule, a solution of diphenylene-diamine hydrochlorate. The yellow colour formed at the zone of contact of the two liquids disappears on contact with alkalies, and re-appears on acidulating the liquid.

New Methods for Detecting the Artificial Colouration of Wines.—Jos. Herz.—This paper will be inserted in full, if possible.

Analyses of Old Wines.—Dr. J. Moritz (*Chemiker Zeitung*.—The results are given in the form of tables.

Differences between Natural Butter and its Artificial Substitutes. — E. Scheffer. — The solubility diminishes regularly with the increase of the proportion of grease mixed with the natural butter.

New Determination of Tannin. — H. Dieudonné (*Chemiker Zeitung*).—Already noticed.

Determination of Fatty Acids in Soaps. — B. Schulze.—Already noticed.

Proportion of Alkaloids in Narcotic Extracts.—E. Dietrich.

Determination of Colchicine.—A. Kremel.

Assay of Coca Leaves.—Kœhler.

Assay of the Purity of Cocaine Hydrochlorate.—O. Antrick.—These four papers have a purely pharmaceutical interest.

Determination of Morphine in Opium and its Preparations.—O. Schlickum.—For the assay of opium 3 grms. of the powdered sample are digested in a closed vessel with 15 grms. alcohol at 70 per cent and 15 grms. of distilled water. The mixture is agitated frequently for twelve hours, and is then poured upon a filter. The filtrate is weighed, a few drops of ammonia are added until the reaction is distinctly alkaline, and it is then boiled down to half its volume. It is then made up to its original weight with distilled water and filtered again; 21¼ grms. of this filtrate are treated with 0·4 grm. ammonia at 10 per cent, and 5 grms. ether; it is well shaken up several times during a couple of hours and let settle. After having drawn off the ethereal layer with a pipette as completely as possible, the precipitate is thrown upon a small weighed filter, washed twice with 2 c.c. of distilled water, and then dried at 100° C. until the weight is constant. The weight of the morphine thus separated should not be less than 0·2 grm.

On the Tungsten-Steel Industry.—The proportions of tungsten introduced into steel range from 2 to 8 per cent. It is added when the steel is in full fusion, and the metal is still kept liquid and well agitated for half an hour.

Colouration of Polished Brass.—E. Ebermayer.—The articles are passed into boiling baths composed of various salts. According to the duration of the contact the shades obtained are more or less intense.

The Aromatic Hydrocarbons in the Mineral Oils of the Caucasus. — Markownikoff. — From *Liebig's Annalen*.

Manufacture of Maize-Starch in America.—G. Archbold.—From the *Journal of the Society of Chemical Industry*.

Chemical Assay of Tissues.—The solubility of animal fibres in strong alkaline liquids, and the insolubility of vegetable matter under the same circumstances is a summary way of detecting wool in presence of vegetable matter. Mineral acids and acid salts, on the contrary, have no action on animal fibres, whilst they gradually carbonise vegetable fibres. [Both these latter propositions must be occepted with reservations]. Animal fibres are coloured yellow by nitric acid, and turn red if heated in Millon's reagent (mercuric and mercurous nitrate). These phenomena are not produced with vegetable fibres. Vegetable fibre (cellulose), as well as silk, dissolves readily in ammoniacal copper oxide, and the former can be re-precipitated by a number of salts, by sugar, and by gum. Silk can be re-precipitated only by the aid of weak acids. According to Peligot a solution of copper oxide in ammonia, well fitted for reacting on tissues, may be obtained by dissolving in a little ammonia with access of air, copper filings, or electrolytic powder of copper. Nitric acid without apparently attacking vegetable fibres dissolves silk in time and colours wool yellow. According to Schlossberger the ammoniacal solution of nickel oxide dissolves silk very readily without attacking cotton. As wool always contains sulphur it may be recognised as follows:—Lead hydroxide, dissolved in caustic alkali, blackens when brought in contact with wool. This test is worthless if sulphured silk is simultaneously present. Liebermann prepares a saturated aqueous solution of magenta and adds caustic alkali by drops until the colour has disappeared. The liquid is then filtered and the tissue in question is immersed in the filtrate and washed in much water. The wool in the tissue then appears coloured red, whilst cotton remains colourless. Silk behaves like wool. Persoz finds that silk dissolves readily in a hot solution of zinc chloride at 60° B. On this fact he founds a method of determining the silk quantitatively, which has been subsequently developed. Three samples of the cloth (2lbs. each) are boiled in 200 c.c. of hydrochloric acid at 3 per cent in order to remove the dressing, and they are then carefully washed and pressed. In case of coloured goods cotton very quickly loses its colour, wool is stripped more slowly and silk more slowly still. Two of the swatches thus prepared are immersed in a boiling solution of zinc chloride containing 850 parts of water, 1000 zinc chloride, and 40 parts zinc oxide. The difference of weight before and after the treatment shows the quantity of silk found in the tissue. On heating the third swatch in 60 to 80 c.c. of caustic soda (at sp. gr. 1·02) for fifteen minutes at 100°, washing and drying the quantity of wool, is shown by the difference of weight before and after treatment. In his work on the structure and assay of silks Hœhnel gives another method for the qualitative and quantitative determination of the different fibres. Mulberry silk behaves quite differently from wild silks with a solution of chromic acid. If a sample of the former is plunged into a solution of chromic acid saturated in the cold and then diluted with an equal volume of water and boiled for one minute, the silk dissolves completely. Wild silks remain apparently unaltered after boiling for two to three minutes. Wool behaves in this solution like mulberry silk. Different kinds of silk behave differently with a boiling and moderately strong solution of caustic potassa in which true silk is attacked more rapidly than adulterated silks. [It does not appear whether this expression refers to weighted silks, or by an abuse of language to wild silks]. To separate wool from mulberry silk the best method is to treat the swatch with boiling hydrochloric acid, in which silk dissolves rapidly and wool swells up, but without dis-

solving. This method may also serve for the quantitative determination of the fibres forming the tissues. To distinguish wool from "adulterated" silks the above-mentioned solution of chromic acid may be used. On heating in this solution wool dissolves very rapidly, whilst the adulterated silks resist. In this manner may be distinguished a mixture of cotton, wool, mulberry silk, and Jamamai silk as follows:—On boiling this mixture in hydrochloric acid the silk dissolves in half a minute; on boiling for two minutes in strong hydrochloric acid the Jamamai silk dissolves. In the residue the wool is dissolved by caustic alkali and the cotton remains unchanged. Cellulose, if treated with acids, is partly transformed into sugar. By taking advantage of this fact, and of the property of sugars to yield beautiful colourations with sulphuric acid and naphthol or thymol, Molisch has devised a new method for distinguishing vegetable and animal fibres. To eliminate every error the swatch should be repeatedly boiled with water to remove any gum, sugar, &c., present in the dressing. In case of wool care must be taken that it does not contain lice or burrs. Molisch then places in a test-tube 0·01 grm. (about) of fibres well boiled and washed in much water; he adds 1 c.c. of water and several drops of an alcoholic solution of naphthol at 15 to 20 per cent, and the liquid is then mixed with an equal volume of concentrated sulphuric acid. If the swatch contains vegetable fibres they dissolve rapidly, and the liquid, on stirring, takes a deep violet colour. If the fibres are of animal origin the liquid takes a more or less intense yellow, even up to a reddish brown. If we use thymol instead of naphthol we obtain, under the same conditions, a colour midway between vermilion and carmine. Silk behaves like the animal fibres. Dyes do not interfere with this reaction. According to A. Lidoff raw silk dissolves rapidly in melted oxalic acid, cellulose slowly, and wool not at all.—*Technik.*

On the Distribution of the Nitrifying Organism in the Soil.—R. Warington.—From the *Journal of the Chemical Society.*

Examination of a Commercial Quinine Sulphate containing Cinchonidine and Hydroquinone.—J. E. de Vrij.—This paper does not admit of useful abstraction.

Industrial Preparation of the Benzoyl Greens.—Dr. O. Muhlhauser.—An account in detail of the manufacture of malachite green, brilliant green, and acid green.

Contributions to the Metallurgy of Bismuth.—Ed. Matthey.—From the Chemical News.

Physical Properties of Manganese Steel.—W. Barrett.—From the Chemical News.

Erratum.—P. 215, foot of col. 1, *for* "W' the weight of ore+water," *read* "W' the weight of the flask + ore + water."

MEETINGS FOR THE WEEK.

Monday, 28th.—Medical, 8.30.
Tuesday, 29th.—Institution of Civil Engineers, 8.
Wednesday, 30th.—Society of Arts, 8.
—— Royal, 4. (Anniversary).
Thursday, Dec. 1st.—Chemical, 8. Ballot for the election of Fellows. "On the Supposed Third Nitroethane," by Prof. Dunstan and T. S. Dymond. "Researches on the Laws of Substitution in the Naphthalene Series," by Prof. H. E. Armstrong, F.R.S.
Friday, 2nd.—Geologists' Association, 8.

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". . . . Likely to be useful to those actually engaged in applied Chemistry, as well as to the Student."—*Journal of Gas Lighting.*
E. & S. LIVINGSTONE, Publishers, Edinburgh.

UNIVERSITY COLLEGE, LIVERPOOL.
SHERIDAN MUSPRATT SCHOLARSHIP.
The competitive Examination for the above Chemical Scholarship will be held at the College on December 8th and following days. The Scholarship is of the annual value of £50, tenable for two years. For fuller particulars regarding subjects of examination and conditions of tenure apply to the College Registrar. Intending candidates must send in their application on or before Thursday, December 1st. Preference is given to candidates under twenty-three on Jan. 1, 1888, though others are not ineligible.

PROF. A. E. FOOTE, of Philadelphia, commences packing the great collection of Minerals and Scientific Books that he has displayed at the American Exhibition, Nov. 29th. As, however, he has just received by express from America a number of his very cheap educational collections, which he can furnish at the very low prices mentioned below, sale continued till December 7th.
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THE CHEMICAL NEWS.

Vol. LVI. No. 1462.

THE ALLEGED SYNTHESIS OF GLUCOSE.

By SAMUEL E. PHILLIPS, F.C.S.

In my "Old or New Chemistry, which is Fittest for Survival?"* I have indicated three properties by which aldehyds form a generic series:—

1st. They dedouble, with $-2HO$.

2ndly. They re-assimilate the $2HO$ in the condensed radical.

3rdly. They form hydro-compounds by assimilation of $2H$.

Benzoin and hydrobenzoin are typical of this series, and hence some are called "oins" with a distinctive prefix.

At page 45 the case of glycer-aldehyd is given:—

2 glycer-aldehyd $-2HO =$

$$\left.\begin{matrix}6\\5\\4\end{matrix}\right\} C_{12}H_9O_8, O.HO \text{ the dialdehyd.}$$

$$+2HO = C_{12}H_{11}O_{10}.O.HO\ (a) = \text{glyceroin.}$$

$$+2H = C_{12}H_{13}O_{10}.O.HO\ (b) = \text{hydro-glyceroin.}$$

Now is (*a*) a re-discovery, or is it now identified with having the properties of an optically inactive *glucose?*

If this theory of its genesis be correct, then it would follow that (*b*) should evince the characters of a *mannite*. That these radicals are chemically correct we *do know* from their amides; to wit, that—

$$(a) + \text{ammonia} - 2HO = C_{12}H_{11}O_{10},H_2N,$$

and (*b*) similarly $C_{12}H_{13}O_{10},H_2N$, or their corresponding azins or oximes.

As we have oxy-alcohols and oxy-aldehyds, which have been mostly obscured by modern hypotheses, so it is infinitely plain that their chemical structures and corresponding properties evince a unity of principle which must command attention and ultimate admiration.

Wokingham Road, Reading.

* Which may be had from the author, post free, 2s.

ON A NEW METHOD OF EXAMINING BUTTER.

By THOMAS T. P. BRUCE WARREN.

A few modifications in the details of manipulation have been introduced since writing the first paper on this subject, which I propose giving on a future occasion. I may just mention here that the addition of only a few drops of cotton-seed oil to 10 grms. of genuine butter-fat give a very cloudy appearance; when the mixture is subsequently treated with carbon disulphide, 10 drops produce a thick, almost black, product.

A matter deserving attention has cropped up recently that I thought it would be interesting to make a special subject of enquiry, so as to make the attack on adulteration more certain and complete.

Evidently all samples of oleo-margarine or butterine do not contain vegetable oils. I am therefore directing attention to the animal products which may be employed in their manufacture, and, on looking for information on the matter of animal oils and fats, I have been fairly surprised at the great blank which our own literature presents.

According to Chateau, who has made a special study of animal fats, the French "graisses" corresponds to the Latin "adeps," and to the English "fat" or "grease." The French "suifs" corresponds to the Latin "sebum" and to the English "tallow." To this portion of the subject I shall refer further on.

The oleo-margarine manufacturer is clearly ahead of our oil experts as to the available materials for butterine manufacture. Only a few days ago I purchased an article sold as butterine and known to be such, as it was supplied as "oleo-margarine," and which consisted of animal fats only. The price paid was sixpence per pound.

When treated with chloride sulphur it turned black after a few hours standing; pure butter turns to a light brownish colour, but does not blacken, and, in order to find an explanation for this curious result, I made a special examination of the different animal fats aud oils within reach. I found that commercial oleic acid thickens and turns quite black; animal oleine turns very dark, the products in both cases being soluble in carbon disulphide. Lard made from the omentum of the pig behaved so much like butter that I feel I should be encouraging a fraud, until I can pronounce definitely on it one way or the other.

As no substance rich in stearine is admissible as a butter substitute, increased attention should be directed to the animal oleines which are now commercial articles. The hard fats, known ordinarily as tallow, are used by oleo-margarine manufacturers for producing the better classes of butterine; the stearine is removed by pressure, the fat being melted and kept at about 80° F.

Only a few days ago my attention was called to an analysis of American lard oil, which consisted approximately of equal parts of oleine and cotton-seed oil. The oleine was not obtained from the fat of the pig.

Fats may be divided into two classes, the *soft* fats being represented by "lard," and the *hard* fats which are represented by "tallow."

Chateau points out that the Greek word *Stear* is used for both kinds of fats, but it is very remarkable that no language in Europe employs the identical term for both kinds of fatty substances.

Confining our attention to fat or grease (Lat. *adeps*, Fr. *graisse*), Chateau says that in usual parlance we give the name "fat" or "grease" to a fatty substance more or less soft, but soft solids at ordinary temperatures,—such are obtained from mammals and birds: it is found in cavities in adipose tissue, and accumulates principally —though in variable proportions—along the surface of the intestines, in the double membrane of the epiploon, around the kidneys, between the flesh and skin, in the lower cardiac region, and other parts of the body.

Chateau says that the taste and smell of these fats are very faint and not disagreeable. Their consistency varies according to the part of the animal from which it has been extracted; under the skin and around the kidneys it is firmer than in the neighbourhood of the movable viscera. The higher or lower fusibility and the softness of the fat depend on the proportion of oleine which these fats contain.

I have no hesitation in saying that these fats referred to by Chateau enter more largely into oleo-margarine than the oleine from hard fats. Their rich and moderately greasy flavour are not at all repugnant; many of them have the taste and flavour of good dripping which collects when meat is being roasted.

Most of these oils or greases thicken and turn black with chloride sulphur, and could not be added to butter without being detected. The nauseating idea is that our alimentary canal is liable to be utilised as a means of emptying Mother Grub's stock-pot; the idea may upset one's power of deglutition, but this appears to be a small matter to be taken into account when compounding artificial butter.

Ammoniacal Copper Sulphate.—Cupric compounds are now used with sucess as a remedy for the *Peronospora viticola*. M. Casthelaz bases his processes on preparing the ammoniacal sulphate extemporaneously in the midst of the copper solutions.—*Moniteur Scientifique.*

ON REMARKABLE RELATIONS BETWEEN THE SPECTRUM OF WATERY VAPOUR AND THE LINE SPECTRA OF HYDROGEN AND OXYGEN,

AND ON THE

CHEMICAL STRUCTURE OF THE TWO LATTER BODIES AND THEIR DISSOCIATION IN THE ATMOSPHERE OF THE SUN.

By Professor A. GRUENWALD.

(Concluded from p. 224).

III.

The Dissociation of Hydrogen in the Sun's Atmosphere.

AN attentive comparison of the lines of the spectrum of the primary element, *b*, given above, with the corresponding adjacent Frauenhofer lines and those of the chromosphere teaches us that the element *b* must occur in a free condition in the solar atmosphere, and must be identical with helium, of which, hitherto, only one ray was known, D_3 5874·9.

Thereby, as well as by the close agreement of the lines of the *a* spectrum, also given above, with the corresponding lines of the solar spectrum, it is proved that hydrogen occurs in the sun's atmosphere in a state of dissociation.

But if this is the case the constituent *a* must occur not only wherever the dissociation takes place, along with helium, but being the lightest of all gases, it must rise highest above the photosphere in regions which are only exceptionally reached by the much denser helium and the other elements in violent eruption. If this takes place, and if in these very lofty and relatively cool regions helium *b* and the primary matter *a* come in contact, then at the exceedingly low pressure here prevailing we have all the conditions given for the formation of the "modified, ammonioid hydrogen," which emits the second "compound" hydrogen spectrum. Such regions, which correspond with the extreme parts of the corona, will therefore show especially the lines of the second hydrogen spectrum along with those of normal hydrogen.

A gas having the properties above represented seems to be the hitherto unknown corona substance, which emits the only at present known ray 1474 of Kirchoff's scale, or $\lambda = 5315{\cdot}9$ of Ångström's, and which I may be here permitted to name briefly "*coronium*." We may therefore possibly assume that the primary constituent, *a*, of hydrogen is identical with this coronium, which is in any case a distinct substance from helium, since the corona line 5315·9 often remains unchanged, whilst at the same time the helium line, D_3, is either expanded or distorted and displaced, displaying Lockyer's forms of motion.

If this supposition is correct, $\lambda = 5315{\cdot}9$ (approximately) must be a wave-length of the above *a* spectrum, which was not detected by calculation solely because the wave-lengths in hydrogen corresponding to the element *a* are not completely known. In this case $\lambda = 5315{\cdot}9$, multiplied by $\frac{2}{3}$, must be converted into a wave-length of the elementary H-spectrum. Now certainly the wave-length $\frac{2}{3} \times 5315{\cdot}9 =$ (about) 3544·0 does not occur in the list of the wave-lengths known at present as belonging to hydrogen, but if we compare the second very rich section of the H_2O spectrum (II. I.) corresponding to the hydrogen spectrum as given by Dr. Hasselberg, it answers in a very satisfactory manner to the criteria (II. 5*a*) for H-rays which belong to the body *a* in hydrogen, since—

$$\frac{1}{3}\frac{9}{0} \times 3544{\cdot}0 = 2244{\cdot}5,\ \frac{3}{4} \times 3544{\cdot}0 = 2658{\cdot}0,$$

and—

$$\frac{3}{7}\frac{6}{8} \times 3544{\cdot}0 = 2646{\cdot}1,$$

deviating only by a few tenths of an Angström's unit (10−7 m.m.) from the corresponding wave-lengths of the H_2O spectrum, 2244·8, 2658 6, 2645·4. The ray at about $\lambda = 3544{\cdot}0$ is therefore a hitherto unknown ray of hydrogen, the existence of which will in future admit of experimental verification, $\lambda = 5315{\cdot}9$ is a wave-length (formerly escaping calculation from the deficiency of data) of the primary element *a*, the latter being therefore probably identical with coronium.

I must not, however, neglect to mention that the line 5317·28 of Dr. Hasselberg's II. hydrogen spectrum lies very close to the corona line 5315·9, and, according to what has been said, will probably be observed in the relatively cooler regions of the corona, far remote from the photosphere. If these two lines are really distinct from each other it should be possible, under favourable circumstances, to observe both simultaneously in the corona, 5315·9 in the hotter region nearer the photosphere, and the other in the cooler region more remote from the photosphere.

Similar is the case with the well-known line of the chromosphere, $\lambda = 4471{\cdot}2$ of Rayet (Lorenzoni's *f*), which deviates only by 0·3 from the adjacent line of that part of the II. hydrogen spectrum which Dr. Hasselberg mentioned in 1884, *i.e.*, the line $\lambda = 4470{\cdot}9$, as well as from the chromospheric line $\lambda = 4712{\cdot}5$, which, like 4471·2, is rather a band than a line, and like the latter is ascribed to *Ce*, but differs only by 0·6 from the nearest line of the II. H-spectrum, 4713·1.

The line 4471·2, which I was inclined to take for a helium line, does not belong to helium, as it does not display the characteristic mathematic-spectroscopic criteria of the helium lines. This is confirmed by the observations made by Prof. Young, August 3rd and 5th, 1872, according to which at the same time when D_3 5015·0, 4571·4, &c., were strongly disturbed, the lines 4471·2, 7055, and the corona line 5315·9 remained unaffected. As regards the approaching total eclipse of the sun, I would call special attention to the circumstance that, according to my calculations and comparative researches, the lines of Ch. Fievez (4612·5, 4564·5) of Young (5570, 5450), of Tacchini (4943 and 5031), and, what is very important, two lines very near the Mg lines *b* and b_2 at 5183·3 and 5172·3 belong to helium, but the line 7055 very probably to coronium. Finally, the lines observed by Capt. Abney and Dr. Schuster in Egypt, May 17th, 1882, *i.e.*, the lines of the spectrum of the corona 4501, 4473, 4401, 4224·4, 4212, 4195, 4179, 4085, and 4067, as well as one at least of the four red lines seen at the same time by Tacchini, 6489, 6492, 6494, 6498, of the corona belong to the II.nd "compound hydrogen spectrum."

The lines seen by the last-named spectroscopists and astronomers in the corona must probably, therefore, as already shown, belong to a relatively cooler portion of the corona very remote from the photosphere. In this region the elements of hydrogen, which were separate in the hotter districts, re-unite partly to form ordinary hydrogen, and partly to the modified ammonioid hydrogen, which emits the II.nd H-spectrum.

PS.— Whilst the above matter is in the press, a new and remarkable confirmation of the wave lengths of the spectrum of water, as foretold by me on May 9th of this year ($\lambda = 2331{\cdot}1$ to $\lambda = 2437{\cdot}2$), has been supplied by Prof. G. D. Liveing.

ON THE EFFECTS PRODUCED BY SMALL QUANTITIES OF BISMUTH ON THE DUCTILITY OF SILVER.

By Surgeon-Major J. SCULLY, Assay Master, Calcutta.

(Continued from p. 226).

II. As it seemed likely that a large number of experiments would be required to determine accurately the smallest amount of bismuth that would injure the ductility of our coinage alloy, and the still smaller proportion that would not sensibly affect this ductility, it was determined to begin the enquiry by a number of laboratory experments on small bars of silver, before trying the effects of bismuth on ordinary coinage bars and with the procedure for lamination carried out in the Mint. These laboratory

experiments were made in the following way:—Pure silver prepared for assay check purposes, or an alloy of silver and copper of which the exact composition had been determined by assay, was melted in a clean plumbago crucible under charcoal. When the metal was in fusion the necessary amount of bismuth was rolled in a piece of paper, carried down at once to the bottom of the silver bath, and then thoroughly mixed with the silver by stirring. The calculated composition was confirmed by assay of the silver. When this mixture had been accomplished, the contents of the crucible were poured into an open iron ingot mould, and after cooling—either quickly by plunging the casting into water or slowly in contact with the mould—the bar so cast was tested for brittleness by hammering and rolling. The bars cast were of two sizes, one set being 3·75 inches long, 1·125 broad, 0·375 thick, and weighing about 6·2 troy ounces; and another set 2·69 inches long, 1·125 broad, 0·25 thick, and weighing about 4·1 troy ounces. When reduced to the fullest extent by rolling, these bars were converted into straps about 0·015 inch in thickness. In laminating them they were twice annealed, first after having undergone four pinches in the rollers, and again after the tenth pinch from the beginning. Similarly shaped bars of silver, without bismuth, were occasionally laminated in the same way to obtain a sure means of comparison. Before any result was accepted as to brittleness or its absence, the bar under experiment was always re-melted and tried at least a second time. The number of experiments in this series amounted to *fifty-three*, and the following is a summary of the results obtained:—

Fine silver when alloyed with only 1 per mille (one-thousandth part of its weight) of bismuth, and the casting rapidly cooled by plunging it into water as soon as it has set, has its ductility, as tested by lamination, sensibly but slightly impaired, the straps resulting from rolling having slightly jagged edges. When the proportion of bismuth is increased to 2, 3, 4, and 5 per mille, the plan of cooling remaining the same, the raggedness of the edges of the straps was somewhat increased, but not very markedly. If, however, the casting was allowed to cool down completely, but very slowly, in contact either with the mould or a stone floor, the results were very different. Under this condition of cooling, a bar composed of fine silver with 4 per mille of bismuth was completely brittle; it was readily broken, and its fracture was strongly crystalline. On laminating it small cracks appeared all over the surface on the second pinch, the bar emitting a crackling sound under the rolls, much like the "cry" of tin, and on the fourth pinch the bar cracked deeply at the edges. This remarkable effect on the molecular structure of this alloy of silver and bismuth, as due solely to the mode of cooling the casting, was repeatedly verified on the same metal by re-melting and cooling rapidly and slowly alternately. The case seems analogous to that of bronze, where slow cooling of the alloy after casting is said to make it hard and brittle.

Fine silver with 6 per mille of bismuth, rapidly cooled, was distinctly cold-short and crystalline on fracture; the bar cracked on the surface at the fourth pinch. With 7 per mille of bismuth these evidences of diminished ductility were slightly more pronounced. With 8 per mille of bismuth the silver was still more brittle, the bar broke readily when hammered, and cracked all over the surface on the fourth pinch from the rolls. With 9, 10, and 11 per mille of bismuth, the bar of silver could be readily broken in two by merely striking it against the edge of an anvil, the fracture was coarsely crystalline, and the bar, in one case, proved to be very red-short, a mere tap from the tongs sufficing to break it in two when heated for the purpose of annealing. Although these bars were so very brittle, it was still possible to roll them into thin straps after careful annealing; but the edges of the straps so produced were deeply jagged and indented by cracks. These bars also all emitted the peculiar crackling noise under the rolls which has before been mentioned.

An alloy containing 990 parts of silver and 10 of copper then had added to it successively 1, 2, 3, 4, and 5 per mille of bismuth, the castings being rapidly cooled. The remarks already made with reference to fine silver alloyed with the same proportions of bismuth would apply here almost exactly,—that is to say, the bars were rolled out to a thickness of 0·015 with somewhat ragged edges, so that although ductility, as thus tested, was impaired, it was only slightly so. With 6 per mille of bismuth (fineness of metal on assay 983·9) the edges cracked a little, and, after annealing and rolling out, the strap had decidedly jagged edges and was split for some distance at one end. The bars containing 4, 5, and 6 per mille of bismuth were now re-melted and allowed to cool slowly and completely in the mould. They were all found to be highly brittle, broke easily under the hammer,—the fracture being granular and not crystalline,—and on being rolled they cracked badly, all over the surface and at the edges, on the first or second pinch; in one case the bar broke in two on the second pinch. That these very different results were again solely due to the manner of cooling was proved by re-melting and rapidly cooling the castings, when the same metal proved comparatively ductile, as first stated.

Silver of the Indian standard of 916·6 per mille (the rest being copper) to which 2 per mille of bismuth was added, gave on lamination straps with slightly jagged edges and proved to be red-short. With 4 per mille of bismuth the bars showed a few surface cracks on being rolled, and the resulting straps had decidedly jagged edges. Slow cooling of these castings did not affect their ductility, thus showing a marked contrast to what had been observed in the case of fine silver and the alloy containing only 10 per mille of copper. When the amount of bismuth was increased to 5 per mille, the copper present remaining at 83·4 per mille, the bars were decidedly brittle and cracked readily on hammering,—the fracture being again granular, and not crystalline as in the case of fine silver. On lamination both surface and edge cracks developed after four pinches from the rolls, and in annealing one of these bars the whole surface blistered considerably, no doubt owing to the temperature having been carried a little too high. Standard silver with 10 per mille of bismuth, reducing the fineness as ascertained by assay to 906·6, was very brittle, the bars breaking easily under the hammer, and on the fourth pinch from the rolls splitting and cracking all over the surface. In the course of these latter experiments it was ascertained that, with from 83·5 to 70 per mille of copper present, slow or rapid cooling of silver alloys containing bismuth made no appreciable difference in their ductility.

The foregoing experiments having furnished some information as to the amount of bismuth that might be expected to injure our coinage alloy, it was now decided to test that point practically, by operating on coinage bars subjected to the regular procedure for the manufacture of rupees in the Calcutta Mint. The experiments made in this connection were *fourteen* in number. The bars used here for coinage weigh about 253 troy ounces, and are about 20 inches long, 2·25 broad, and 1 inch thick; they are cast in vertical iron moulds. In lamination they are first reduced by eleven pinches to a thickness of 0·23 in.; they are then annealed, and finally reduced by twelve additional pinches to a thickness of 0·06 inch. A number of bars, poured from a pot of which the contents had proved on assay of a granulated sample to be 916·6 fine, were selected for the experiments, and as a preliminary step one of the bars was laminated to test its ductility. It rolled out with smooth "wire" edges, and indeed its ductility was beyond suspicion, as it resulted from a melting of good coins. Another bar of the same batch was now melted and 1 per mille of bismuth added to it, the result of the addition being checked, in this and all following cases, by the assay of a granulated sample of the metal, taken after thorough stirring. At the eighth pinch both edges of the lower half of this bar began to

crack, and at the eleventh pinch these cracks extended towards the middle line of the strap for about a quarter of an inch, and occurred at about every half inch of the edge. After annealing, and in the subsequent lamination to a thickness of 0·065 inch, these cracks increased considerably in number, but did not become sensibly deeper. The strap as finished was pronounced unfit for coinage purposes; for although two blanks could have been cut from its width, the edges were too jagged to admit of the blanks being obtained exactly along the line from which it was desired to cut them,—this position being attained by means of a fixed lateral guide against which the edge of the strap had to be maintained in cutting. With 2 per mille of bismuth the results obtained on rolling were not much worse than with 1 per mille. But the side cracks opened out more, and here again it was noticed that the lower portion of the bar (upper and lower here having reference to the casting in upright moulds) was somewhat less ductile than the upper part.

With 3 per mille of bismuth (fineness on assay 913·8) the bar began to crack on both edges at the ninth pinch; at the eleventh pinch there were many cracks quite a quarter of an inch deep, and after annealing the bar these cracks increased at every pinch, so that at the twenty-first pinch the strap was cracked all along both edges very badly. It would only have been possible to obtain one blank from the width of this strap.

As it was perfectly clear that no further experiments were required with larger proportions of bismuth, the subsequent trials were made on coinage bars containing 0·5 per mille, 0·25 per mille, and, by dilution of the latter bars with standard silver, to even half and a quarter of the lesser proportion just stated. Here the results were rather discordant; they appear to have been somewhat influenced by the state of different rolls, and by quick or slow annealing. The general outcome of the tests, however, was that although some of the straps containing the proportions given of bismuth were jagged at the edges, and so would have yielded a diminished percentage in outturn of good blanks, others were not materially worse than the average of straps without any bismuth at all. As a result of this part of the enquiry, it may, I think, be fairly concluded that if our coinage bars contain less than 0·5 per mille of bismuth their ductility will not be materially affected. It must be borne in mind that these results only apply to bars of the size and shape of those experimented on, and with the particular treatment in lamination above detailed. With thinner bars and a different method of rolling, different results may be expected. The system of cutting out blanks has also to be considered, for in some mints straps with saw edges are not so prejudicial as in others.

(To be continued).

THE METHODS EMPLOYED IN THE ANALYSIS OF IRON ORES,

TOGETHER WITH A

SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID.*

By A. A. BLAIR.

(Continued from p. 227).

C. Chancel (*Compt. Rend.*, li., 882) treated the iron ore with HNO_3, precipitated any H_2SO_4 with $BaCl_2$, and HCl with $AgNO_3$; precipitated the Ag and reduced the iron with H_2S, boiled off in current of CO_2, and precipitated P_2O_5 with nitrate of bismuth. The precipitate contained 31·28 per cent P_2O_5.

R. Warington, jun. (*Jour. Chem. Soc.*, xvi., 304) recommended the use of citric acid instead of tartaric acid, to avoid the precipitation of Mg salts with the—

$Mg_2(NH_4)_2P_2O_8$.

Fr. Mohr (*Zeit. Ann. Chem.*, ii., 250) showed that the precipitate in a solution of iron by sodic phosphate had the formula $Fe_2O_3P_2O_5$. On long washing the precipitate was decomposed, P_2O_5 and Fe_2O_3 dissolving with an acid reactive.

Schloessing (*Compt. Rend.*, lix., 384) ignited the phosphate in a mixture of SiO_2, then transferred to a carbon boat, and heated in a porcelain tube in a current of CO. The loss of weight was P_2O_5. If the porcelain tube is connected with a silver tube heated to redness and containing Cu, the Cu takes up all the P from its volatile compound; or if the gas from the porcelain tube is led into a bulb apparatus containing $AgNO_3$ and warmed in a water-bath to 80° or 90° C., the silver phosphide collected here and the red phosphorus remaining in the tube may be oxidised with HNO_3, evaporated to dryness, heated to incipient fusion, extracted with water, and the residue weighed as $3Ag_2OP_2O_5$.

R. Warington, jun. (Chem. News, xi.) recommended neutralising the nitric acid solution after separation of SiO_2 with NH_4HO, and precipitating with acetate of lead (or with $Pb(NO_3)_2$ and PbO). The lead phosphate, after washing with warm water containing some ammonic acetate, was dissolved in dilute HNO_3 and decomposed with H_2S. From the filtrate, which contained all the P_2O_5 with very little iron, the P_2O_5 was precipitated after the addition of a little citric acid by Mg mixture.

R. Fresenius (*Zeit. Anal. Chem.*, iii., 446) remarked, in regard to the molybdate method: 1. HNO_3, even in large excess, did not influence the exactness of the method. 2. HCl in large amount prevented, partially or entirely, the precipitation of the phospho-molybdate; 3·3 per cent of HCl gave results that were approximate, but still too low. 3. In the presence of much HNO_3, HCl was still more disadvantageous. 4. H_2SO_4, Fe_2Cl_6, Al_2Cl_6, even in large amount, did not influence the result. 5. With much NH_4Cl the results were too low, as they were also when the solution was very dilute.

F. Knapp (*Zeit. Anal. Chem.*, 1865, 473) and R. Pribram (*Vierteljahrschr. Pr. Pharm.*, xv., 184) claimed that in a solution containing much Al_2O_3 the precipitation of the $Mg_2(NH_4)_2P_2O_8$ in the presence of tartaric acid and ammonia was entirely prevented.

J. Spiller (*Jour. Chem. Soc.* (2), iv., 148) treated the HCl solution with ammonic bisulphide, drove off the excess of SO_2 by heating, cooled the solution to 20° C., and added a solution of ammonic carbonate until the precipitate, at first red, became greenish in colour. This precipitate, which contained all the P_2O_5, was filtered off and dissolved in HCl, the iron separated according to Fresenius's method by $(NH_4)_2S$ and NH_4HO, and the P_2O_5 precipitated in the filtrate by Mg mixture.

Brassier (*Ann. Chem. Phys.* [4], vii., 355) suggested the use of $MgCl_2$ instead of $MgSO_4$.

E. G. Tosh (Chem. News, xvi., 168) recommended Spiller's method, but instead of separating the Fe_2O_3 and P_2O_5 by $(NH_4)_2S$ and NH_4HO, added citric acid to the HCl acid solution to the precipitate by ammonic carbonate, and precipitated the P_2O_5 by Mg mixture and ammonia, as $Mg_2(NH_4)_2P_2O_8$.

Tantin (Chem. News, xviii., 252) proposed treating iron or steel with HCl in a flask, and passing the gases evolved through a solution of KHO to separate S, and then through a solution of nitrate of silver in which the phosphuretted hydrogen precipitates silver as phosphide. This phosphide of silver he filtered off and treated with aqua regia, which oxidised the P to P_2O_5 and rendered the Ag insoluble as chloride. The AgCl he filtered off, and determined the P_2O_5 in the filtrate.

W. Kübel (*Zeit. Anal. Chem.*, viii., 125) showed that $Mg_2(NH_4)_2P_2O_8$ was much less soluble in ammonia water than Fresenius supposed. As he found basic magnesic sulphate in this precipitate, he recommended re-solution and re-precipitation.

E. Kessel (*Zeit. Anal. Chem.*, viii., 164) stated that the amount of basic magnesic sulphate precipitated with the

* From "Mining Industries of the United States."

$Mg_2(NH_4)_2P_2O_8$ was very small if no great excess of $MgSO_4$ was used and sufficient NH_4Cl. He also claimed that the presence of soluble Mg salts decreased the solubility of the $Mg_2(NH_4)_2P_2O_8$, and that dilute ammonia dissolved it, the solvent action of this latter being increased by the presence of NH_4Cl.

Th. Petersen (*Verhandl. Geolog. Reichsanst.*, 1869, 80) re-stated the necessity for completely removing SiO_2 before precipitating P_2O_5 by molybdate solution.

F. Kessler (*Jour. Pr. Chem.* [2], 2, 364) proposed to determine P in iron and steel by precipitating the Fe from solution by K_4FeCy_6, and in the filtrate determining P_2O_5 as $Mg(NH_4)_2P_2O_8$.

Meinicker (*Zeit. Anal. Chem.*, 1871, p. 280) suggested dissolving iron or steel in double chloride of copper and ammonium, filtering, and treating the residue with HNO_3, and precipitating P_2O_5 in this solution with molybdate solution.

E. Richters (*Zeit. Anal. Chem.*, 1871, 305) recommended washing the precipitate of ammonic phospho-molybdate with solution of ammonic nitrate.

E. W. Parnell (CHEM. NEWS, xxiii., 145) showed the insolubility of $Mg_2(NH_4)_2P_2O_8$ in ammoniacal liquids containing excess of Mg salt or sodic phosphate.

J. Parry (CHEM. NEWS, xxv., 229) dissolved iron or steel in aqua regia, and after separating SiO_2 transferred the HCl solution to a flask and added sufficient ammonia to precipitate all the Fe_2O_3, then just enough HNO_3 to dissolve the precipitate. He heated the solution nearly to boiling, and added an excess of an aqueous solution of ammonic molybdate. If there was no precipitate he added HNO_3, drop by drop, shaking the flask constantly until a distinct precipitate appeared, after which he added a small additional amount of HNO_3, shook the flask well, and allowed the precipitate to settle for a few minutes. He filtered, washed with water containing a little HNO_3, and weighed the precipitate of phospho-molybdate of ammonia, which contained 1·63 per cent of P.

T. R. Ogilvie (CHEM. NEWS, xxxi., 274; xxxii., 5, 12, 70) made a number of experiments to show the effect of varying amounts of Mg salts, citric acid, Al_2O_3, Fe_2O_3, and ammonic oxalate on the precipitation of P_2O_5 as $Mg_2(NH_4)_2P_2O_8$.

E. W. Parnell (CHEM. NEWS, xxxii., 222) said, in answer to Ogilvie, that the purity of the precipitate of $Mg_2(NH_4)_2P_2O_8$ was not affected by the quantity of the Mg salts, but by the manner of precipitation. He recommended the use of dilute solutions, and said they should stand quiet for a long time.

W. Flight (*Jour. Chem. Soc.*, xxviii., 592) discussed various methods and recommended:—

1. To separate P_2O_5 from Fe_2O_3, he passed H_2S through the weak acid solution, then added $(NH_4)_2S$ in excess, boiled, filtered, washed with H_2S water, and determined P_2O_5 in filtrate.

2. From Al_2O_3 he added excess of NaHO to solution then $BaCl_2$ to precipitate all the P_2O_5, allowed to stand several hours protected from CO_2, filtered and washed with NaHO water, decomposed precipitate and determined P_2O_5.

3. From Fe_2O_3 and Al_2O_3 he treated the not too acid solution with excess of $Na_2S_2O_3$, boiled, filtered P_2O_5 partly with Al_2O_3 in precipitate and partly with FeO in filtrate. He then separated P_2O_5 by methods I and II.

T. E. Cairns (*Am. Chemist.*, vii., 215) showed the inaccuracy of Sonnenschein's molybdate method when the solution was not heated above 40° C., unless it was allowed to stand several days. He recommended dissolving the iron or steel in HCl and $KClO_3$, evaporating to dryness to get rid of SiO_2, precipitating the Fe_2O_3 and P_2O_5 by NH_4HO, filtering, dissolving this precipitate in HNO_3, and evaporating down, diluting to 250 c.c., neutralising by NH_4HO, adding "molybdate solution," heating nearly to boiling and allowing the phospho-molybdate to settle. He recommended washing this precipitate with "molybdic acid solution," dissolving in NH_4HO, neutralising by HCl, and precipitating the P_2O_5 by Mg mixture.

(To be continued).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, November 17th, 1887.

Mr. WILLIAM CROOKES, F.R.S., President, in the Chair

MESSRS. EDWIN J. BALL and David Lloyd Howard were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Peter Coulson Burn, Jun., King's Lynn, Norfolk; F. Barker Cooke, 40, Wilson Road, Camberwell, S.E.; Agnew Griffith, Daisy Mount, Blundell Sands, Liverpool; Frank Edward Lease, Caledonia Estate, Province Willesley, Straits Settlements; Edmund George McBretney, 25, Denton Terrace, Castleford, Yorks.; W. Sedgwick Saunders, M.D., 13, Queen Street, Cheapside, E.C.

The following papers were read:—

81. "*Zinc-copper and Tin-copper Alloys.*" By A. P. LAURIE.

The author finds that if the zinc plate of a Daniell cell be replaced by a compound plate formed by joining copper and zinc, the cell has the same electromotive force as one in which zinc alone is used; this is true, even though the zinc surface be only 1-1000th part of the copper surface. If the zinc plate be replaced by copper-zinc alloys, no deflection of the electrometer is observed as long as the alloy contains less than 67 per cent of zinc; at this point, however, a big deflection, practically equivalent to that given by zinc, is suddenly obtained. This result, in the author's opinion, may be taken as evidence of the existence of a compound of the two metals of the formula $CuZn_2$. Alloys containing a greater proportion of zinc behave like zinc alone. Similarly in the case of tin-copper alloys, a sudden rise of electromotive force is observed when the proportion of tin in the alloy exceeds that which would be contained in a compound of the formula Cu_3Sn. This result is in harmony with the evidence already obtained by observations of the density and thermal and electrical conductivity of the copper-tin alloys. If an alloy containing a larger percentage of tin than Cu_3Sn, in a state of fine division, be placed in a copper cup and used in place of the zinc in a cuprous chloride cell, the excess of tin is gradually eaten out, leaving approximately the alloy Cu_3Sn; this alloy undergoes no change if the circuit be kept closed.

DISCUSSION.

Dr. WRIGHT, after asking whether the author had made any experiments with ternary alloys, referred to observations which he had had occasion to make on lead-zinc-tin alloys. It is well known that lead and zinc will not permanently mix, but that on cooling the lead separates with a little zinc and the zinc with a little lead: he had found that tin behaved itself indifferently to the two metals, dividing itself between them; but the zinc appeared to be able to take up more lead, and the lead more zinc, in presence of the tin.

Mr. BALL said that under Professor Robert Austen's direction he had made experiments on the effect of melting lead—a metal which does not alloy with copper—with copper-tin alloys; it was found, however, that the lead had no influence, the copper-tin alloy separating out unmixed.

Professor RAMSAY suggested the application of the author's method to lead-tin alloys, which appeared to be but "solidified solutions."

The PRESIDENT drew attention to the fact that amalgams presented many peculiarities. Thus iron, antimony, sodium, silver, and gold will dissolve in mercury: but if antimony amalgam be mixed with sodium amalgam the antimony is thrown out—iron also.

82 "*The Halogen Substituted Derivatives of Benzalmalonic Acid.*" By C. M. STUART, M.A.

The author describes the preparation of orthochlorobenzaldehyde, orthobromobenzaldehyde, and orthiodobenzaldehyde, and their transformation into the corresponding halogen substituted benzalmalonic acids; and the decompositions which these acids and *o*-methoxybenzalmalonic acid undergo when boiled with water: on the one hand (Eq. I.), into benzaldehyde and malonic acid; and, on the other (Eq. II.), into carbon dioxide and cinnamic acid (see accompanying table; comp. *Trans.*, 1886, 357). On reduction, orthonitrobenzalmalonic acid yields the carbostyrilcarboxylic acid described by Friedlander and Göhring.

	Boiled for one hour. Decomposition according to			Boiled for fifteen minutes. Decomposition according to		
	Eq. I.	Eq. II.	Total.	Eq. I.	Eq. II.	Total.
Benzalmalonic acid..	85·8	10·8	96·6	57·8	1·41	59·2
	84·4	10·6	95·0	58·3	1·25	59·5
Orthonitrobenzalmalonic acid.	24·5	5·7	30·2	8·70	1·18	9·88
	23·6	6·5	30·1	8·71	1·25	9·96
	24·4	6·4	30·8	—	—	—
Orthochlorobenzalmalonic acid	65·17	8·40	73·57	30·8	3·36	34·16
	64·35	9·64	73·99	30·8	3·47	34·27
Orthobromobenzalmalonic acid	66·0	10·6	76·6	33·0	3·22	36·22
	67·6	10·2	77·8	32·3	2·84	35·14
Orthiodobenzalmalonic acid..	67·6	9·09	76·69	33·0	3·5	36·5
	65·7	10·09	75·79	31·9	3·0	34·9
Orthomethoxybenzalmalonic acid	78·1	8·16	86·2	45·9	2·72	48·62
	76·4	9·27	85·6	44·0	2·04	46·04

83. "*Note on a Modification of Traube's Capillarimeter.*" By H. S. ELWORTHY.

The author describes a modification of Traube's instrument for determining fusel oil in spirit by measuring the capillary depression, the essential feature being that the tube is fixed at an angle approaching the horizontal instead of vertical. In Traube's instrument a pure 20 per cent (by volume) spirit is said to rise 50 m.m.; but in the author's modification the rise is 173 m.m., and 1 per cent of fusel oil produces a depression of 25 m.m. instead of only 7 m.m.

84. "*The Formation of Hyponitrites: a Reply.*" By EDWARD DIVERS, M.D., F.R.S.

The paper on the "Formation of Hyponitrites," by Professor Dunstan and Mr. Dymond (*Trans.*, 1887, 646), which I received a few days ago, contains some references to papers by Mr. Haga and myself, and by me alone, which are erroneous, and place us in a false position.

(1). In the section headed "Discussion of Results," p. 656, the authors say:—"We are unable to confirm the statement made by Divers and Haga that ferrous hydroxide in presence of alkali does not form hyponitrite from nitric oxide?" Such a statement has not been made by us. All that we have said on this subject occurs in two lines near the end of a short paper describing the formation of hyponitrite from nitric oxide by acting on it with potassium stannite, in reference to the only experiment we have made with ferrous hydroxide and nitric oxide, one in which we employed strong solution of potassium hydroxide with the ferrous hydroxide. Our words were (*Trans.*, 1885, 364): "Neither hydroxylamine nor hyponitrite could be detected as products of this reaction." The authors record their repetition of this experiment, with results the same as ours (p. 649), and have thus actually confirmed our only statement in the matter. The authors signally confirm, also, our other experience with ferrous hydroxide, in failing, like us, *by Zorn's process*, to reduce nitrites and nitrates to hyponitrites.

(2). The authors find that I regard "the formation of hyponitrites as due to the direct *withdrawal* of oxygen from the nitrite or nitrate by the metal" (p. 657), and give as references my first paper on "Hyponitrites" (*Proc. Roy. Soc.*, 1871), and subsequent communications, more particularly that "On the Production of Hydroxylamine from Nitric Acid," presented to this Society. For the very sufficient reason, however, that I have as yet formed no clear notion of the constitution of hyponitrites, I have never offered any formal theory of their formation, unless it be the very one offered by the authors themselves, incidentally given in my discussion of the reduction of nitric acid by metals (see below). Nowhere otherwise in that paper, nor at all in any other communication, have I treated of the theory of the formation of hyponitrites, so far as I can find. In my first paper occurs only the equation $NO_2Na + 2Na = NONa + Na_2O$, and the bare statement that the sodium reduces the nitrite. The authors were, therefore, hardly in the position to state that I regard its formation as due to the direct withdrawal of oxygen, the word withdrawal italicised, in order plainly to make a contrast to their supposition that first sodium nitrite directly combines with hydrogen. I have long ago expressed the latter view myself, but I should still express *the result* of the reaction by the above equation in my first paper.

(3). The authors further find me to suggest "that a compound of the formula $NaNONa_2$ is formed by the *substitution*" (the italics again are theirs), "of two atoms of sodium for one of oxygen in the nitrite—

$$NaNO_2 + 4Na = NaNONa_2 + Na_2O$$"

(p. 657). But at the place referred to (*Trans.*, 1883, 458) there is only the equation—

$$Zn(NO)_2 + 4Zn = Zn_2N_2O_2Zn + 2ZnO,$$

together with words which have rightly led the authors to write 2Na for Zn, and halve the formula. Of the substitution of metal for oxygen there is neither word nor implication in my paper. $Zn_2N_2O_2Zn$, or Na_2NONa, is clearly hydroxylamine with zinc or sodium in place of hydrogen, but the authors have, by some strange error, written, three times over, as my formula, $NaNONa_2$. Such an unjustifiable mode of writing, it may serve to illustrate the absurd view they attribute to me, that two atoms of sodium are substituted for one of the atoms of the oxygen of the nitrite (!), but no such view is expressed or countenanced in any paper of mine. The authors will, I am sure, agree with me that a position-formula, which contains two or more groups of atoms of the same element, does not preserve its meaning when re-written with another arrangement of its symbols.

(4). Having shown the insufficiency of the views they attribute to me, incorrectly as I have just pointed out, the authors proceed to advance a view of their own, which is

nevertheless to be found stated explicitly in that communication of mine to the Society, to which they principally refer. They say:—"The hypothesis we wish to suggest as at once the simplest and most in accordance with the facts, supposes that the sodium nitrite first directly combines with two atoms of hydrogen. The formula of the new compound will be $Na{\cdot}N : (OH)_2$, or perhaps $NaONH{\cdot}OH$. This substance will, on the one hand, split up into sodium hyponitrite and water—

$$2NaN(OH)_2 = Na_2N_2O_2 + 2H_2O,$$

and on the other be acted on by hydrogen, yielding hydroxylamine and sodium hydroxide,—

$$NaN(OH)_2 + H_2 = NH_2OH + NaOH.$$

More hydrogen will yield ammonia . . ." (p. 657). Essentially all that is contained in the above extract is given by me in my paper on the "Production of Hydroxylamine from Nitric Acid" (xliii., 443). I there suggest that nitrous acid "passes next to a transition-body capable of decomposing to hyponitrous acid, but readily passing on directly to hydroxylamine, thus:—

$$HNO_2 + H_2 = HN(OH)_2 = HNO + OH_2,$$

or otherwise,

$$HN(OH)_2 + 2H = H_2NOH + OH_2,$$

a repetition of which action would give ammonia" (*op. cit.*, p. 462).

I have much less confidence than the authors appear to have, as to the sufficiency of this view, which was indeed only expressed by me incidentally in connection with the reduction of nitric acid, and I should not have felt induced to assert my claim to it now, had the authors confined themselves to putting it forward as new, and not, with many references to my papers, erred in representing me as having advanced only other and extravagant views.

85. "*Reply to the Foregoing Note.*" By W. R. Dunstan.

1. As regards the interaction of nitric oxide and ferrous hydroxide, the statement quoted by Dr. Divers in par. 1 is only a fair interpretation of his own words. If Dr. Divers believed that hyponitrite was formed, but could not be detected in presence of the excess of alkali (which we have shown to be the case), misunderstanding would have been avoided had he explicitly said so, although there would have been, at that time, an absence of experimental evidence for the suggestion. This reference to Zorn's process does not correctly represent our conclusion. We found, contrary to the experience of Divers and Haga, that hyponitrite can be formed from nitrite by a process which is substantially that proposed by Zorn.

2. We certainly had gathered from Dr. Divers's papers that he regarded the formation of hyponitrite from nitrite as the result of the direct withdrawal of oxygen by sodium, and not of the intervention of hydrogen. The habitual exclusion of water from his equations is in itself a sufficient justification for our statement. I fail to find in any of Dr. Divers's papers an expression of the view that, in the formation of sodium hyponitrite by the action of sodium on sodium nitrite, water is the necessary link in the series of interacting compounds, and that the hydrogen of this water first attaches itself to sodium nitrite.

3. The "absurd view" that we had attributed to Dr. Divers has arisen from a misunderstanding of his formula Na_2NONa, or, as we had written it, $NaNONa_2$. The equation he gives certainly involves the substitution of sodium for oxygen, but Dr. Divers now explains that the resulting compound is to be regarded, not as a sodium derivative of sodium nitrite, but as a metallic derivative of hydroxylamine.

4. I am surprised to find that Dr. Divers claims as his own the hypothesis we have suggested to account for the formation of hyponitrite and hydroxylamine from nitrites and nitric oxide. He admits that he has never fully discussed the general question. He has proposed a similar theory to account for certain decompositions of nitric acid by the tin zinc metals, but he nowhere attempts to show that an analogous change takes place when sodium acts on dissolved sodium nitrite. Moreover, there is no recorded evidence that Dr. Divers had noticed the significance of the *simultaneous* formation of hyponitrite and hydroxylamine from sodium and sodium nitrite, and he certainly had not shown that the hydroxylamine was not derived from the hyponitrite; on the contrary, he has suggested that hyponitrite does yield hydroxylamine when hydrogenised (*Trans.*, 1885, 204). It may fairly be said that Dr. Divers was not even in possession of the facts which our hypothesis was devised to explain. My only object in writing this rejoinder is to point out the grounds for attributing to Dr. Divers the views to which he now takes exception. I am glad to find that after all our interpretations of the facts do not appear to be so divergent as I had formerly supposed.

PHYSICAL SOCIETY.

November 26th, 1887.

Dr. Balfour Stewart, President, in the Chair.

Mr. Asutosh Machopadhyay, M.A., F.R.S., was elected a member of the Society.

The following communications were read:—

"*On the Analogies of Influence Machines and Dynamos.*" By Prof. S. P. Thompson, D.Sc.

The author pointed out that in nearly all influence machines there are two stationary parts ("inductors") electrified oppositely which are analogous to the field magnets of dynamos, and a revolving part carrying "*sectors*" which correspond to the "*sections*" of an armature. To prevent ambiguity Prof. Thompson proposes to call the inductors "*field plates*" and the revolving parts as a whole an "*armature*."

In the Winshurst machine both field plates and armature rotate, and each act as field plates and armature alternately.

In the two field-plate influence machines there are four, and sometimes six, brushes. Two of these act as potential equalisers, two as field-plate exciters, and the remaining two (if any) are generally placed in the "discharge" or external circuit.

The Holtz machine having only four brushes, two serve the double purpose of potential equalisers and discharge circuit, and this machine excites itself best when the discharging rods are in contact. In this respect it resembles a series dynamo, which only excites itself when the external circuit is closed, but on opening the circuit (say by inserting an arc lamp) produces remarkable effects. So in the Holtz machine, on separating the discharging knobs a shower of sparks result.

The Toepler machine (made by Voss), having six brushes, resembles a shunt dynamo, and excites itself best on open external circuit.

Analogues were traced between Thomson's replenisher and the Griscom motor.

Armatures of influence machines, as in dynamos, can be divided into ring, drum, disc, and pole armatures, and examples of each kind were mentioned. The "Clark gas-lighter" is a good example of a drum armature, and a diagram showing the internal arrangements was exhibited.

An example of an analogue to the compound dynamo was mentioned as existing at Cambridge in the form of a Holtz machine believed to have been modified by Clerk Maxwell.

Another analogy with dynamos is found in the displacement of the electric field when the armature is rotated, just as the magnetic field of a dynamo is shifted round in the direction of rotation.

Further analogies were traced between "critical velocity" of dynamos (which depends on the resistance in the circuit) below which they do not excite themselves,

and a similar critical velocity of influence machines; *e.g.*, in a Wimshurst or Voss machine the potential equalising circuit should have a low resistance if they are to excite themselves readily.

Self-exciting dynamos excite better when the iron is bad and retains its magnetism, and influence machines excite better when the field plates are made of paper or such substance as can well retain a residual charge.

Finally, an apparatus analogous to Thomson's water-dropping accumulator was exhibited, in which an electric current was generated by mercury falling down a tube between the poles of a magnet.

Prof. AYRTON pointed out an historical analogy between the inventions of the influence machine and the dynamo; for as Varley anticipated Thomson in the invention of the self-exciting influence machine, so Hjorth anticipated Varley, Wheatstone, and Siemens in the invention of the self-exciting dynamo.

Dr. FLEMING considered that, just as all influence machines may be looked upon as descendants of Volta's "electrophorus," so dynamos are those of Faraday's "coil and magnet."

"*On the Effect produced on the Thermo-electric Properties of Iron, when under Stress or Strain, by raising the Temperature to a Bright Red Heat.*" By Mr. HERBERT TOMLINSON, B.A.

In June last the author described some remarkable "Effects of Change of Temperature on Twisting and Untwisting Wires which have suffered Permanent Torsion," of which the present paper is a continuation. It is found that at or about the critical temperature (a bright red heat), mentioned in the previous paper, a sudden E.M.F. is generated at the junction of two iron wires, one of which is under stress or has suffered permanent strain, and the other in an unstrained state. By suddenly bringing a red-hot iron wire in contact with cold iron, an E.M.F. of about $\frac{1}{10}$ volt is produced. If copper be used the E.M.F. is about $\frac{1}{5}$ volt.

The author also showed that if one part of an annealed iron wire is heated to a bright red by a Bunsen flame, an E.M.F. is generated if the position of the flame is slightly altered, the direction of the E.M.F. depending on the direction of the displacement.

Prof. AYRTON believed the high E.M.F. exhibited by hot and cold copper was really due to oxide of copper; and Prof. S. P. THOMPSON said that different effects could be produced by using the oxidising or reducing parts of the flame in heating the wire.

"*On a Method of discriminating Real from Accidental Coincidences between the Lines of Different Spectra, with some Applications.*" By E. T. J. LOVE, M.A.

The differences between the measured wave-lengths of the lines to be composed are arranged in groups, each group containing those observations the errors of which lie within certain narrow limits. The number of observations in each group is then plotted as ordinate and the average error of the group as abscissæ, and the resulting curve drawn. The coincidences are deemed real or accidental according as the resulting curve does or does not resemble the curve of errors, $y = a\,\varepsilon^{-c^2x^2}$.

Interesting applications bearing on the presence of cerium in the sun, and on Prof. Grimwald's recent investigations relating to the constitution of so-called "*elements*," are appended.

OBITUARY.

PROFESSOR BLOXAM.

WE regret having to put on record the death of Professor Bloxam, which took place on Monday morning, 29th ult. For about a week previously he had been suffering from an attack of acute bronchitis. As most of our readers know, the deceased was an indefatigable and meritorious worker in chemistry. He formerly contributed to the CHEMICAL NEWS a number of very useful analytical notes. These he called his "holiday tasks," as they were the fruit of researches carried on during the vacations, as he never left London. He held the chair of chemistry at King's College, and was greatly admired as a lecturer. His principal published work was "Chemistry, Inorganic and Organic," an excellent manual.

Prof. Bloxam was interred yesterday, December 1st, at the Charlton Cemetery.

NOTICES OF BOOKS.

Gas-Works Statistics. Edited by C. W. HASTINGS. London: Scientific Publishing Company (Limited).

EITHER gas-works are much more numerous than water-works or their officials are more communicative than the secretaries and managers of water-works. The columns seem much better filled up. No establishment seems this year to have performed the feat of selling a considerable quantity of gas more than it has produced. In Bury the sales slightly exceed the manufacture, but the quantity is so small—362,000 cubic feet—that it may have been in stock at the beginning of the year. Dartford and Normanton have exactly disposed of their entire yield.

The illuminating power of the gas supplied seems to have increased, perhaps from a wholesome dread of the electric light. As far as England is concerned Berwick still leads the list with its thirty-candle gas; twenty-two towns are supplied with gas at twenty-candle power or upwards. At the bottom of the list figure Yarmouth and Baslow with thirteen-candle gas, and Theale with twelve.

Whether from a superior quality of material or from greater skill, Scotch gas-works still keep ahead of those in England in illuminating power. Banchory comes first with its thirty-three-candle gas; twenty-two towns have gas of thirty-candle power or upwards, whilst the lowest returns we find are twenty-four and twenty-five candles respectively.

The Gas and Water Companies' Directory, 1887. Edited by CHARLES W. HASTINGS. London: Scientific Publishing Company.

THIS work will be of manifest utility to the numerous persons who are brought into business relations with the Companies in question. We find arranged in parallel columns, opposite the name of each town or locality, the date of formation of the undertaking; the date of special Act, if any; the total paid up share capital, dividends, total loan capital issued; the names of chairman, engineer or manager, and secretary; the lessee, owner, or corporation; the population, distance from London, and the railway by which the place is accessible.

The populations given are not those of the towns, but of the entire districts supplied by the gas- or water-works, and which often extend far beyond the municipal limits. The reader who does not bear this in mind will stumble upon apparent contradictions. Certain Companies appear to have furnished no returns.

Water-Works Statistics, 1887. Edited by C. W. HASTINGS. London: Scientific Publishing Company (Limited).

WE are pleased to notice in this edition a great improvement as compared with the issues in former years. The very useless column, stating whether the water-supply of a town was brought by pumping or by gravitation, has been suppressed. In its stead we find columns showing the character of the water and the death-rate. We cannot but regret that some towns have omitted to give particulars under these heads. Among these defaulters rank Liverpool, Newcastle and Gateshead, Roch-

dale, Rotherham, Ashton-under-Lyne, Brighton, Bristol, Cambridge, Sheffield, &c. The degrees of hardness given range from 2 to 20. Descriptions of waters given without any analytical data are less satisfactory. Thus one town describes its supply as "very pure and soft," another as "excellent," and a third as "first class purity."

The sources of supply seem now to be stated with more regard to the geological character of the district. Three towns describe their water as softened by the Clarke process, and one by that of Dr. Atkins. A few towns still refrain from giving any statistics whatever. Of course if town clerks, secretaries to companies, &c., neglect to furnish the information, the Editor has no means of compelling them; but we must repeat what we have stated in a former year, that these returns, if they could be rendered complete, would be a most valuable document in relation to public health.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cv., No. 19, November 7, 1887.

On the State of Potash in Plants, the Soil, and Vegetable Earth, and on its Determination.—MM. Berthelot and André.—The variation in the quantities of potash obtained in aqueous, ammoniacal, acetic, nitric, hydrochloric, &c., extracts of a soil depends on the alteration of the silicates during calcination. They show that the potash of the soil cannot be determined without we eliminate the silica. It is necessary to estimate all the potash of the soil capable of intervening in reactions more or less slow. No precise line of demarcation can be drawn between the potash of the soil which is immediately assimilable and the potash capable—not to go further—of intervening in the course of a year's vegetation. It is not enough to determine the potash extracted on treating the soil either with pure cold water or with cold dilute acid. Not only is this determination imperfect, as the portion rendered soluble varies with the temperature and the other conditions of the experiment, but it is so small a fraction of the total potash that it can teach us nothing of value either on the reserve-stock of potash in the soil or on the complementary proportion of potassic manures.

On a Diterebenthyle.—Adolphe Renard.—The composition of this compound, which is obtained by a tedious process from the volatile oils of resin, is $C_{20}H_{30}$. Its sp. gr. at 18° is 0·9688, its index of refraction is 1·53, and its rotatory power + 59°. Its vapour density is 9·6. In its properties it borders on the carbides of the terebic series. If spread out in a thin layer in contact with air it absorbs, in fifteen days, about one-tenth of its weight of oxygen, and is transformed into a pitchy varnish. Chromic acid in an acetic solution, converts it into carbonic acid and carbon monoxide. Potassium permanganate, in a watery solution, converts it into carbonic, formic, acetic, and propionic acids.

Metallic Derivatives of Acetyl-acetone.— Alphonse Combes. — The author has shown in former memoirs that the hydrogen atoms of the central chain, CH_2, characteristic of acetyl-acetone, present remarkable analogies with the hydrogens of the acid hydroxyls. They are not attacked by the direct action of chlorine, and they can be easily substituted by sodium. He now shows that acetyl-acetone and its homologues act upon metallic salts like true strong acids, and that we may thus obtain with all the metals a new class of definite crystalline compounds, the acetyl-acetonates, answering to the general formula $(C_5H_7O_2)nM$, M being a metal of n atomicity.

An Artificial Textile Fibre resembling Silk.—M. de Chardonnet.— The author dissolves 3 grms. of nitrocellulose in 100 to 150 c.c. of a mixture of equal parts of alcohol and ether. He adds 2·5 c.c. of a filtered solution at one-tenth of the dry ferrous chloride of commerce in alcohol, or of stannous chloride, and further, 1·5 c.c. of a solution of tannic acid in alcohol. The whole is filtered in a closed apparatus to prevent loss by evaporation. The liquid is placed in a vertical reservoir, having at its bottom a blowpipe nozzle of glass or platinum. This pipe forms an acute cone with an orifice of from 0·10 to 0·20 m.m., the thickness of the margin not exceeding 0·1 m.m. This aperture opens into a vessel of water acidulated with ½ per cent of mono-hydrated nitric acid. The level in the reservoir being some centimetres higher than in the vessel of water, the outflow proceeds easily. The fluid thread hardens at once in the acidulated water, and may be drawn out by a uniform movement. The thread thus formed must be dried rapidly by traversing a current of dry (not hot) air, and may be wound up as soon as dry. It is grey or black, but a number of soluble colouring-matters may be introduced into the ethereal solution, thus obtaining threads of all colours.

Moniteur Scientifique, Quesneville.
Series 4, Vol. i., July, 1887.

Tanning by Means of an Alkaline Extract of Coal.—P. F. Reisch.— By digesting coal-dust with caustic soda at a boil and neutralising this liquor with hydrochloric acid, the author obtains a new tanning agent, which he names pyrofuscine. He considers that the new process is more complicated than the usual tanning processes, but that it is 50 per cent cheaper than the bark process, and 20 to 30 per cent cheaper than the alum process.—*Dingler's Polyt. Journal.*

Laboratory Apparatus for Fractional Distillations.—P. Monnet.—This paper cannot be intelligibly reproduced without the accompanying illustration.

Industrial Review and Various Patents.—A collection of specifications mostly relating to colouring-matters.

Exhibition of the Chemical Society of Paris.—M. de N.—This society has again got up an exhibition of chemical products at the Conservatoire des Arts et Metiers. The author, in concluding, says:—"Do not let us forget that chemistry, a science modern and completely French, has now become cosmopolitan."

Use of Glycerin to prevent Wool from being injured by prolonged Exposure to Heat.—J. Persoz.— The author finds that wool, if previously saturated with a 10 per cent solution of glycerin, can bear a prolonged exposure to 130° to 140° without injury.

Journal fur Praktische Chemie.
New Series, Vol. xxxv., Parts 6 and 7.

Researches from the Chemical Laboratory of the University of Leipzig.—These consist of papers by B. Hotte on the action of phenylhydrazine on the anhydrides of bibasic acids, especially phthalic anhydride, and by J. H. Reed on the methyl-derivatives of the naphthoquinolines and on β-naphtho-acridine.

Studies on the Manufacture of Santonine. — A. Busch.—An account of this manufacture as carried on at Orenburg.

On Solid Hydroxilised Hydrogen Phosphide.—B. Franke.—Solid phosphorus oxide, commonly so-called, is an oxyhydrogen phosphide, of a feebly basic character. The hydrogen in its phosphide can be replaced by powerful alkalies.

Some Constant Apparatus for Generating Gases. Chr. Sleenbuch.—This memoir requires the accompanying diagram.

The Addition of Sodium-acetacetic and Sodium-malonic Ethers to the Ethers of Non-saturated Acids.—A. Michael.—This paper does not admit of useful abstraction.

Reduction of *a* and Allo-*a*-bromo-cinnamic Acids to Cinnamic Acid.—A. Michael.—The solution of the bromo-acid in glacial acetic acid was treated with zinc-powder, when a liberation of hydrogen occurs after the addition of a few drops of a dilute solution of platinum chloride.

On Aromatic Hydroxylamines.—A. Michael and G. M. Browne.—The authors obtain pikrylhydroxylamine by the action of picric ethyl ether upon hydroxylamine.

Analysis of the Mother-Liquor and the Saliferous Water of a Lake situate near the Stolupin Mineral Springs.—P. Bulitsch.—A memoir of merely local interest.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Colour Lakes.—Can any of your readers give me the names of any really good works on the preparation and properties of colour lake?—R. Lloyd.

MEETINGS FOR THE WEEK.

Monday, 5th.—Medical, 8.30.
—— Royal Institution, 5. General Monthly Meeting.
—— Society of Arts, 8. "The Elements of Architectural Design." by H. H. Statham.
—— Society of Chemical Industry, 8. "On the New Weldon-Pechiney Process for the Manufacture of Chlorine from Magnesium Chloride," by Professor Dewar, M.A., F.R.S.
Tuesday, 6th.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
Wednesday, 7th.—Society of Arts, 8. "The Chemistry, Commerce, and Uses of Eggs of Various Kinds," by P. L. Simmonds.
Thursday, 8th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— Mathematical, 8.
—— Telegraphic Engineers, 8.
Friday, 9th.—Quekett Club, 8.
—— Astronomical, 8.
Saturday, 10th.—Physical, 3. "Optical Properties of Phenyl-thiocarbimide," by H. G. Madan. "Recalescence of Iron," by H. Tomlinson. "On the Rotation of a Copper Sphere and of Copper Wire Helices when freely suspended in a Magnetic Field," by Dr. H. C. Shettle.

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FURTHER CONTRIBUTIONS TO THE METALLURGY OF BISMUTH.*

By EDWARD MATTHEY, F.S.A., F.C.S.,
Assoc. Roy. Sch. Mines.

§ 3. *Bismuth: its Separation from Copper.*

In the Paper upon this interesting metal, which I had the honour of bringing under the notice of the Royal Society in February last,† I referred to the difficulties with which the treatment of bismuth is surrounded when associated with other metals, by any very rapid or comprehensive process.

During the conduct of my operations in the reduction of bismuth from its ores, and its subsequent refining, I have frequently found this metal to contain a small proportion of copper, an element most detrimental even in small traces, and hitherto, I believe, only eliminated by a wet process, costly in practice and tedious in operation, it being necessary by such method to dissolve up the whole of the alloy and precipitate the bismuth in the usual manner—a bulky operation, and one requiring a considerable amount of time. It became therefore advisable, in order to treat cupreous bismuth rapidly and upon a commercial scale, to effect this separation, if possible, by means of a dry process.

In this I have succeeded.

Having observed, in conducting experiments with bismuth and its sulphides, that sulphide of bismuth becomes very easily impregnated with copper, I made the simple experiment of fusing the cupreous bismuth with bismuth sulphide, and found it possible by this means to remove every trace of copper, the sulphur readily combining with the metallic copper.

In this absorption a proportion of bismuth is reduced equivalent to the amount of copper taken up in the operation.

The residual bismuth and copper sulphides thus produced amount to but a small proportion in comparison with the quantity of alloy treated, and the bismuth is readily recovered by subsequent reduction and re fusion.

Large quantities of alloy can be treated at one operation, and the bismuth so freed from copper is available for commercial purposes. I have found it better, when bismuth is associated with other metals, such as arsenic, antimony, lead, tellurium, &c., as well as with copper, to separate all these metals (see former papers) before attempting to remove the copper by the foregoing method.

The operation has been conducted successfully upon many thousands of pounds of similar alloy, and the following figures will show the results obtained in one case, as an example:—

Weight of cupreous bismuth treated = 314 lbs., containing 0·10 per cent of copper, equal to approximately 0·3 lbs.

	Pounds.
From the operation described I obtained of bismuth free from copper	282·0
Of bismuth subsequently reduced and refined from the skimmings	29·9
And bismuth left in residues for further treatment with larger quantities (by determination)	2·0
	313·9
Copper from the skimmings	0·2
Copper left in residues	0·1
	0·3

Thus the whole of the copper and of the bismuth, within a small fraction, is accounted for, the latter being obtained as commercially pure bismuth *and wholly free from copper*.

As the above operation shows, the first separation frees 90 per cent of the bismuth *at once* from the copper associated with it.

It may be as well to state that I have effected complete separation with bismuth containing proportions of copper varying from one-tenth of 1 per cent to 1 per cent by the above process.

* A Paper read before the Royal Society, November 23rd 1887.
† Chemical News, vol. lv., p. 71.

ISOMERIC NAPHTHALENE DERIVATIVES.*

Valuable contributions to our knowledge of the naphthalene derivatives have been made during the past year by Bamberger, Cléve, Ekstrand, Forsling, Guareschi and Biginelli, and others; my own investigations have also progressed very satisfactorily; and from the results obtained it is more than ever obvious that the information to be derived from the study of naphthalene derivatives will be of considerable importance, as it will unquestionably serve to throw light on the nature of the changes involved in the formation of substitution derivatives generally, and on laws of substitution.

Sulphonation of α-mono-derivatives.—The behaviour of α-chloro- and bromo-naphthalene was referred to in the last report; that of α-iodo-naphthalene has since been found to be precisely similar, as this compound yields the 1 : 4 sulphonic acid as main product, together with an isomer. The latter, however, has not yet been obtained in sufficient quantity to satisfactorily determine its specific characters. The 1 : 4 sulpho-chloride crystallises in massive prisms, melting at 123°; bromine at once displaces the sulpho-group in the acid, forming 1 : 4 iodo-bromo-naphthalene (m.p. 88°).

α-Cyano-naphthalene yields an acid which forms well-characterised salts, &c.: this is undoubtedly an α-sulphonic derivative, as it is converted by fusion with potash into an *hydroxycarboxylic* acid, from which α-naphthol may be obtained by removal of carbon dioxide. The hydroxy-acid appears not to be identical with the α-hydroxy-acid prepared from α-naphtoic acid; if this be the case it is to be anticipated that, although the sulphonic acids prepared from α-naphtoic acid and from α-cyano-naphthalene are both α-α-derivatives, the one will prove to be the 1 : 1′ and the other (probably the cyano-compound) the 1 : 4′ derivative. In any case, however, the behaviour of α-cyano-naphthalene affords another example of the modification of the "meta law" which prevails in the benzene series in favour of the "alpha law" to which reference was made in the previous report. These experiments on α-derivatives have been made by Mr. S. Williamson.

Dichloro-naphthalene-sulphonic acids.—With the object of characterising the dichloro-naphthalenes, and in order to obtain more material for the determination of the laws of substitution, a systematic study of the sulpho-acids obtainable from the dichloro-naphthalenes has been commenced and already extended to five of them by Mr. W. P. Wynne and myself; the examination of the dichloro-naphthalenes melting at about 61°, obtained from various sources, has afforded results of special interest, which serve to throw light on the constitution of several of the compounds referred to in the previous report, and has also led to the discovery that two distinct dichloro-naphthalenes have hitherto been confounded together.

1. It was suggested in the former report that the sulpho-acid formed from α-$C_{10}H_7Cl$ in small quantity, together with the 1 : 4 acid was an α-α-derivative; if, so, it should

* Second Report of the Committee, consisting of Professors Tilden and Armstrong (Secretary), appointed for the purpose of investigating Isomeric Naphthalene Derivatives. (Drawn up by Professor Armstrong). Presented to the British Association, Manchester Meeting, 1887.

give either the 1 : 1′ or 1 : 4′ dichloro-naphthalene on treatment with PCl_5. Actually, however, it is found to yield a dichloro-naphthalene melting at about 61°—the melting-point of Cléve's θ-modification—thus proving it to be an α-β-derivative.

Now there is reason to believe that, as a rule, if a β-hydrogen atom become displaced it is one contiguous to an α-position which is already occupied; it is therefore probable that the dichloro-naphthalene in question and the parent sulphonic acid are 1 : 2 derivatives. The acid obtained on sulphonating the dichloro-naphthalene gave a sulpho-chloride melting at 113°.

2. The chloro-acid obtained as chief product on sulphonating β-$C_{10}H_7Cl$ was said by Arnell to yield a dichloro-naphthalene melting at about 61° when distilled with PCl_5: on repeating the experiment, it was found that the product fused sharply at 65°. The sulpho-acid prepared from this dichloro-naphthalene gave salts similar to those obtained from the acid prepared from the dichloro-naphthalene discussed in the preceding paragraph, and its sulpho-chloride fused at 119°. A very small quantity of the products from α-$C_{10}H_7Cl$ was at disposal, but a very considerable quantity of those from β-$C_{10}H_7Cl$, which could therefore be carefully purified; and as the formation of a 1 : 2 derivative on sulphonating β-$C_{10}H_7Cl$ appears highly probable, it is believed that the slight differences observed were due to impurity in the products from α-$C_{10}H_7Cl$. It is thought desirable provisionally to term the dichloro-naphthalene melting at 65° *homo-θ-dichloro-naphthalene* = θ-$C_{10}H_6Cl_2$, as it is probably a *homo-nucleal* compound.

3. On treating the ? β-disulphonic acid, referred to in the previous report, with PCl_5, a dichloro-naphthalene is obtained which also melts at about 61·5°; this, however, yields a sulpho-acid distinct from that obtained from the dichloro-naphthalene from β-$C_{10}H_7Cl$, the melting-point of the sulphochloride being 150°.

4. Cléve has recently described a dichloro-naphthalene melting at 61·5° which he prepared from dichloro-α-naphthylamine. On sulphonating this modification an acid is obtained which is identical with that prepared from the dichloro-naphthalene from the ? β-naphthalene disulphonic acid. It is proposed to provisionally term this dichloro-naphthalene *hetero-θ-dichloro-naphthalene* = θ′-$C_{10}H_6Cl_2$, as there is reason to believe that it is a heteronucleal compound—probably it is 2′ : 4 $C_{10}H_6Cl_2$.

5. It will assuredly be found, on examining the two dichloro-naphthalenes melting (?) at 61° prepared from Cléve's two nitro β-sulphonic acids, that the one is the *homo-* and the other the *hetero-θ-*modification. That obtained from Bayer's modification of β-naphthol-sulphonic acid is doubtless hetero-θ-dichloro-naphthalene: the conclusion arrived at by Claus, that this acid is a 2 : 3 di-derivative, is not only opposed to all that is known of the behaviour of naphthalene compounds, inasmuch as it involves the assumption that on sulphonating β-naphthol the second β-position contiguous to the hydroxyl becomes displaced; it is untrustworthy, as the dichloro-quinone which he obtained may have been, and doubtless was, produced by the action of chlorine liberated during the process of oxidation; and there is reason to believe that the dichloro-naphthalene corresponding to such an acid would be the ε-modification, which melts at 120°.

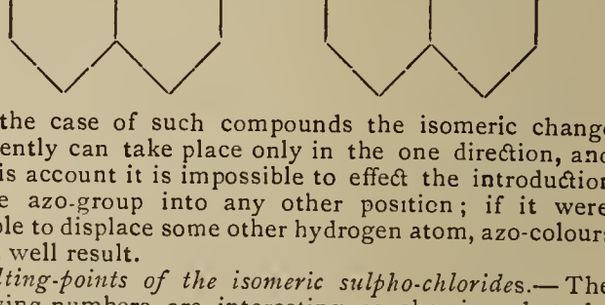
Isomeric change in the naphthalene series.—One of the most striking cases of isomeric change known is that of β-naphthyl-sulphate, $C_{10}H_7.OSO_3H$, into Schaefer's modification of β-naphthol-sulphonic acid by mere warming on the water-bath (*Berichte*, 1882, p. 204). The conversion takes place in the absence of sulphuric acid, and with such ease that there can be practically no doubt that it is a true case of isomeric change; and it is not probable either that the sulpho-group becomes displaced and re-enters the molecule in another position, or that one molecule acts upon another so that an exchange of sulpho-groups is effected. This view is supported by the following more recent observations: first, that if bromo β-naphthol be submitted to the action of SO_3HCl at ordinary temperatures, the resulting product contains very little of the sulphate $C_{10}H_6Br.O.SO_3H$, but chiefly consists of the bromo-naphthol-sulphonic acid, which is formed on brominating Schaefer's naphthol-sulphonic acid.

Again, if β-naphthyl-sulphate be acted upon by SO_3HCl without heating, not only is a second sulpho-group introduced, but that already present *spontaneously* changes its position: a *disulphonic acid* is thus produced which is characterised by the readiness with which it parts with one of its sulphonic radicles, being converted into Schaefer's monosulphonic acid; it is probable that the sulpho-group, which is easily displaced, occupies the α-position contiguous to the OH group. The disulphonic acid here referred to itself undergoes isomeric change when heated, but the nature of the product is not yet finally determined.

Lastly, experiments have been made at my suggestion by Mr. E. G. Amphlett, in which the formation of the sulphate has been prevented by ethylating the naphthol; and it appears that on sulphonating β-$C_{10}H_7.OC_2H_5$ at ordinary temperatures, by means of SO_3HCl, a mixed product is obtained, consisting chiefly of an acid which most probably is the ethylated derivative of Bayer's naphthol-sulphonic acid, together with a small proportion of what is undoubtedly the isomeric ethylated derivative of Schaefer's acid; if, however, the product be heated on the water-bath the former acid is converted into the latter.

These results afford evidence of a most interesting character, both the ease with which the conversion is effected and the variety of isomeric changes which are disclosed being remarkable. Special attention is being directed to the further elucidation of this branch of the enquiry.

Theory of the formation of azo dye-stuffs from β-naphthol.—A series of dye-stuffs of considerable technical value are produced from β-naphthol and its sulphonic acids by interaction with diazo-salts. It is well known that, in the case of β-naphthol itself, the α-hydrogen atom contiguous to the OH group becomes displaced by the azo-group. This position appears to be free in all the sulphonic acids which afford azo-colours, and those naphthol derivatives in which it is not free appear to be incapable of forming such colours; it is therefore a legitimate inference that all azo-dyes derived from β-naphthol are formed by the introduction of an azo-group in the position indicated. The formation of such azo-colours in all probability involves the occurrence of isomeric change, the initial action consisting in the displacement of the H atom of the OH group by the azo-group Az. the compound thus constituted then undergoing change; thus—



In the case of such compounds the isomeric change apparently can take place only in the one direction, and on this account it is impossible to effect the introduction of the azo-group into any other position; if it were possible to displace some other hydrogen atom, azo-colours might well result.

Melting-points of the isomeric sulpho-chlorides.—The following numbers are interesting, as showing that the same change in composition does not always involve a change in physical properties of the same order; it will be noticed that, whereas in the 1 : 4 series the bromo compound has a lower melting-point* than either the chloro- or iodo-compound, in the 2 : 3 series the bromo-

* The melting-point cited is that given by Jolin: the others are from my own observation.

derivative has the highest melting-point; the low melting-point of the 2 : 3′ iodo-sulpho-chloride is also remarkable.

	β(1 : 4)	θ(?1 : 2)
α-Cl.$C_{10}H_6$.SO_2Cl	95°	127°
α-Br.$C_{10}H_6$.SO_2Cl	87°	151°
α-I.$C_{10}H_6$.SO_2Cl	123°	—
	ε(2 : 3′)	θ(?1 : 2)
β-Cl.$C_{10}H_6$.SO_2Cl	109°	130°
β-Br.$C_{10}H_6$.SO_2Cl	125°	147°
β-I.$C_{10}H_6$.SO_2Cl	92·5°	174°

ON A NEW METHOD OF EXAMINING BUTTER.

By THOMAS T. P. BRUCE WARREN.

I HAVE carefully examined the details of the process which I have proposed for detecting frauds in butter adulteration. I do not see any reason to alter the general recommendation contained in CHEMICAL NEWS, vol. lvi., p. 222, for carrying out the test, nor am I able to add anything to make its indication more pronounced, but a few precautions, suggested by working, are necessary. Instead of using 10 grms., I find that 5 grms. are more convenient to work on; the removal of the solvent is accelerated.

Experiments have been mainly directed with a view of finding out:—

Firstly.— Whether any improvements could be introduced in the manipulative part of the process.

Secondly.—What may be expected by using other solvents than carbon disulphide, and the results likely to arise from the action of solvents themselves.

Thirdly.— The modifications which may, advantageously, be used to make the process approximately quantitative.

The influence of animal fatty substances on this reaction I propose to deal with more fully on a future occasion. I may just say that, by a modification of this process, important results seem possible, but as the fats and fatty principles will take some time to prepare, I thought it best to make this subject complete so far as vegetable oils are concerned.

It is necessary to say a few words on the action of sulphur chloride on oils generally. As these compounds are simply mixtures of definite chemical compounds, I prefer to use the terms yellow and dark instead of proto- and dichloride.

When the yellow chloride is added to oils a very violent action takes place; this action is more energetic if the dark chloride be used; on this account I simply regard these bodies mainly as convenient sources of chlorine.

The violent reaction prevents the oil being equally acted on, hence the necessity of mixing the chloride with some suitable solvent; the dark chloride will require diluting with a much larger quantity of solvent than the yellow chloride. The action on castor oil is so violent that a larger quantity of solvent should be used than for any other oil.

As a rule, if the yellow chloride be mixed with an equal volume of solvent it may be added to an oil without any turbulent action setting in. The solvent has an effect beyond its mere power of dilution; this enables it to be well mixed with the oil before the reaction sets in, and by its evaporation the mixture is kept cool and the reaction is more gradual; as soon as the sulphur chloride gets to a certain degree of concentration its action begins. It is not a necessity to expel the whole of the solvent until towards the end of the reaction.

In order to get rid of the obnoxious fumes, the reaction may take place in a small wide mouthed flask, instead of an open dish, and connected with a condenser. The flask is immersed in warm water to facilitate the reaction and to expel the solvent. It must be borne in mind that a portion of the sulphur chloride will pass over into the condenser with the vapour of the solvent. Carbon disulphide is not a pleasant solvent to work with on a large scale, but its use is indispensable, unless we are content to separate the butter fats, mixed with the water, which must be got rid of before adding the sulphur chloride.

If a porcelain dish be used as previously recommended, the residuum, after evaporating the disulphide, should be poured into a stout glass tube and corked, so as to prevent the excess of chloride depositing sulphur, through the moisture in the surrounding air.

Carbon disulphide being heavier than water, the dissolved fats pass only through the filter tube, a little disulphide is poured into the tube before adding the dissolved fats. If we use petroleum spirit, which is lighter than water, the water sinks and is consequently driven through with what it has taken up, in the way of curd and salt.

The presence of water is fatal to the distinctness of the reaction, as it decomposes the sulphur chloride. The uncertainty which is thus likely to be introduced must be provided for. In using petroleum for the subsequent part of the process it should be previously distilled with freshly powdered calcic oxide, so as to remove all traces of water. We must remember that petroleum and carbon disulphide may yield a cloudy mixture; hence, if carbon disulphide be used for the first part of the process, it should be well driven off before adding petroleum, which, by-the-bye, does not dissolve sulphur so readily as disulphide, but with care no difficulty may be feared on this point.

Sulphur chloride cannot be diluted with any solvent containing water, as it is rendered cloudy; on account of this preference is given to carbon disulphide.

In considering the action of solvents a few important facts force themselves upon us. In my paper (CHEMICAL NEWS, vol. lvi., p. 222) I say that the thickened mass, in the case of genuine butter, dissolves perfectly in carbon disulphide; in the case of a vegetable oil being present we obtain a cloudy result. It is safer to note the consistency of the mass, which is unmistakeable when 5 per cent cotton-seed oil is added to pure butter; even 1 per cent could be hardly passed over. Care must be taken to perform these experiments in exactly the same way.

The cotton oil present in a sample of oleomargarine would of itself yield a distinct solid mass, but the animal oils or fats prevent this from their solvent action: it was from this result that I thought there might be a possibility of carbon tetrachloride being formed, which would retard the reaction. With the dark chloride this might be more likely to happen. The yellow chloride is free from this possibility.

These remarks lead us to consider a very important aspect of this matter.

The solvent action of the animal fats prevent our getting a solid mass due to the vegetable oil, but if we add to a suspected sample of butter a quantity of, say, cotton-seed oil, so as to render the quantity of animal fats, as a solvent, much smaller compared with the bulk operated on, we can not only separate out the oil we have added, but also the vegetable oil which previously existed in the oleomargarine.

We can in this way recover the animal fats which have been actually used in compounding the oleomargarine As animal fats and oils are acted upon by sulphur chloride, they are recovered in this changed condition, but by applying the washing process with carbon disulphide carefully, we can, by a process of fractionising, remove first the altered fat and then the unaltered fats, for they vary in their degree of solubility in carbon disulphide.

The quantity of sulphur chloride which I have recommended to be used is due to the fact that cotton-seed oil, in particular, requires a large quantity of chloride; however, if cotton-seed oil be present, a small quantity of chloride will give a pronounced cloudiness, but a

diminished thickening. The solvent action of the chloride cannot be disregarded when in large excess.

The process is best rendered approximately quantitative by adding to a known volume weight of the purified quasi butter fats about the same volume of cotton-seed oil, and after the reaction the increase in weight of the resulting mass when washed with carbon disulphide and dried will be due to the cotton oil present. Of course we ascertain beforehand what the added cotton-seed oil will yield. The oils which give this reaction with sulphur chloride give so far the same weight of product when an excess of sulphur chloride is used, that we shall not be far off the truth if we assume the figure given for cotton-seed oil as applicable to any other oil used in the manufacture of oleo-margarine.

In my next communication on this subject I hope to give a complete numerical result, with details of working, on the quantitative examination of butterine.

The general results of the action of sulphur chloride on oils and fatty substances lead me to believe that the chemical constitution of these bodies is more complicated than we are at present inclined to think.

The glycerin in oils seems to be liberated in this reaction, and although this liquid is insoluble in carbon disulphide, it is removed by this solvent; this is probably due to the presence of other substances which are produced. If a large quantity of sulphur chloride be added, the glycerin is no doubt converted into chlorhydrins. This points to the conclusion that glycerin in oils and fats may be determined without the ordinary saponification treatment. Some altered oil contained in a tube was first washed with disulphide, then dried and subsequently treated with water which contained only a trifling amount of glycerin.

The matter extracted with disulphide is partially soluble in water, and yields an insoluble fatty compound with aqueous solution of potash. The absorption of bromine and iodine by this matter is very remarkable.

The bromide compound is prepared by dissolving iodine in bromine, in the cold, until all fuming ceases. The mass is dissolved in carbon disulphide, which is perfectly miscible with oils, &c. This compound has been made to give a medium reaction, for, as Chateau points out, bromine acts violently, whilst iodine is very slow. Instead of an aqueous solution I use one which is perfectly miscible with oils, and I have applied the same principle of using miscible solvents wherever practicable.

Fuming bichloride tin dissolves readily in carbon disulphide, and is always used wherever a reference has to be made to Chateau's reactions. I propose to deal fully with these matters in some papers which I prepared some time ago for the CHEMICAL NEWS, "On a New Method of Examining Oils, Fats, Resinous and other Allied Substances."

ON GRIQUALANDITE.

By BENNETT H. BROUGH, Assoc.R.S.M., F.I.C.

IN no science is the tendency to introduce new names carried to such an extent as in mineralogy. It is, therefore, of interest, whenever a new name is proposed, to enquire whether that name is really necessary, and to determine whether the supposed new mineral is not essentially identical with one already known. An addition to the ever lengthening list of new mineral names has recently been made in the CHEMICAL NEWS, vol. lv., p. 240, by Mr. Grant Hepburn. The supposed new mineral gave on analysis:—SiO_2, 56·75; Fe_2O_3, 37·64; H_2O, 4·96; FeO, 1·09; MgO, 0·10. Mr. Hepbnrn regards it as a pseudo-morph after crocidolite, having the composition of a ferric silicate, $6SiO_2,4Fe_2O_3,5H_2O$, and assigns to it the name of griqualandite.

From the description of its physical properties, griqualandite appears to be nothing more than the well-known South African brown fibrous quartz, which, under the name of tiger's eye, is largely used as an ornamental stone. This fibrous quartz has been found by Renard to be not pseudomorphous after crocidolite, as is usually supposed, but formed by infiltration of quartz between the fibres of an altered crocidolite. The mineral analysed by Mr. Hepburn differs from the varieties of fibrous quartz analysed by Renard, in containing some 38 per cent less silica, and 33 per cent more ferric oxide. It, however, agrees perfectly with the analysis of brown fibrous quartz by F. Wibel (*Berichte*, vol. vi., p. 185). If the tiger's eye consists of quartz impregnated with ferric oxide and other materials derived from the alteration of the original crocidolite, there is no reason why every gradation, from crocidolite with 50 per cent of silica to pure quartz, should not be met with.

On considering Mr. Hepburn's analysis, it will be found that it corresponds more closely with the simple formula $H_2O.Fe_2O_3.4H_2O$, than with the complicated formula he gives. The percentage compositions demanded by the two formulæ are:—

	SiO_2.	Fe_2O_3.	H_2O.
$H_2Fe_2Si_4O_{12}$	57·42	38·28	4·30
$H_{10}Fe_8Si_6O_{25}$	56·80	37·80	5·33

It is thus seen that the analytical results agree satisfactorily with the composition demanded by the simple formula, with the exception of the percentage of combined water, which in the analysis is 0·66 too high. This may be due to experimental error. It is a curious fact that in all the published analyses of crocidolite, the widest variation is observed in the percentages of water, varying from 1·58 to 5·58. The formula $H_2O.Fe_2O_3.4H_2O$ for griqualandite is analogous to that of crocidolite, acmite, ægirine, and arfvedsonite, all of which have the formula $Na_2O.Fe_2O_3.4H_2O$. Griqualandite may therefore be regarded as a crocidolite in which sodium is replaced by hydrogen. It is not a pseudomorph after crocidolite, but rather a fibrous hornblende or uralite resulting from the alteration of that mineral.

THE ESTIMATION OF SILICON IN IRON AND STEEL.

By THOMAS TURNER, Assoc.R.S.M., F.C.S., F.I.C.

MR. J. JAS. MORGAN, in a note in the CHEMICAL NEWS, vol. vi., p. 221, has made some observations on my second paper on this subject (lvi., p. 49). So far as Mr. Morgan's experiments are concerned there is not so much difference between us as he appears to suppose. The irons analysed by Mr. Morgan always contained under 1 per cent of phosphorus, and generally under 1 per cent of silicon, the highest amount of silicon recorded by him being only 1·78 per cent. With such metal I am quite aware that it is easy to obtain fairly accurate results by any of the recognised processes of analysis. In my experiments no difficulty was experienced in the treatment of metal of superior quality, such as that mentioned by Mr. Morgan. But with commoner irons, often containing over 2 per cent of phosphorus and 3 or even 4 per cent of silicon, the case is different, as those who are in the regular habit of treating such metal will testify.

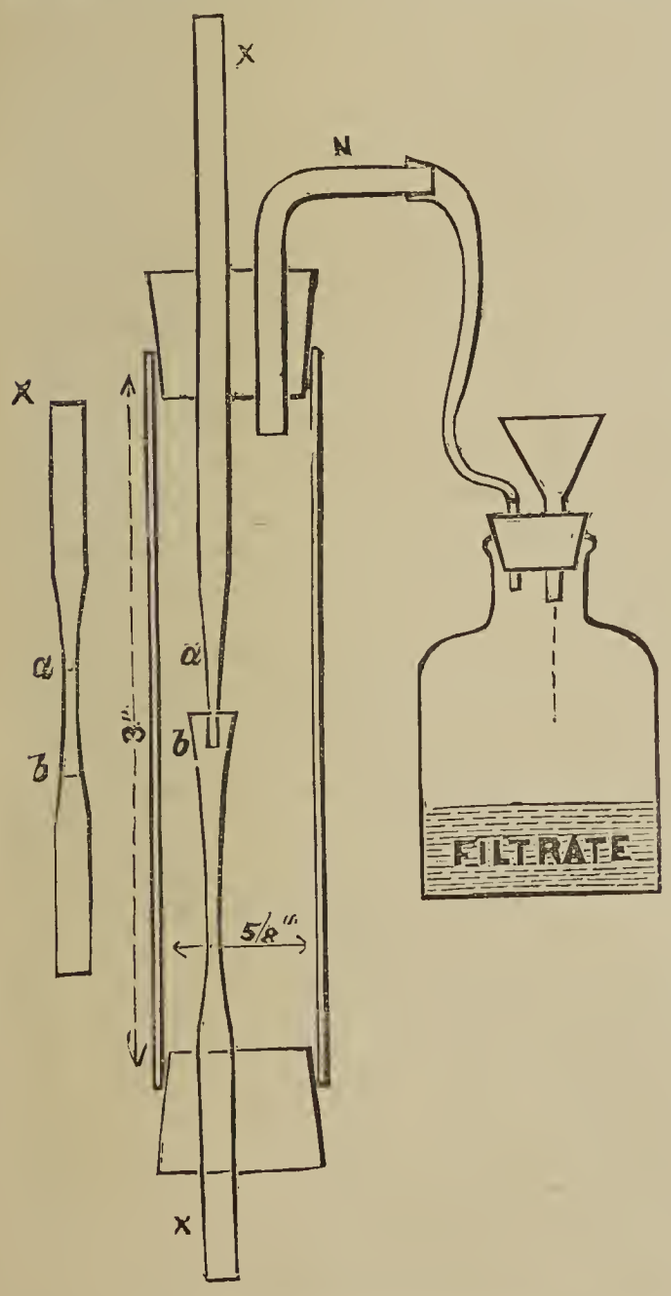
Mr. Morgan is, however, unnecessarily severe in one part of his criticism, which is as follows:—"Mr. Turner also states that with phosphoric irons containing titanium, the silica is contaminated with titanium. From this it is evident that Mr. Turner is ignorant of the fact, viz., that part of the titanium remains behind in combination with the silica, obtained by treating the iron with *aqua regia*, whatever the amount of phosphorus present, be it large or small." In the first place it should be mentioned that my words were as follows, when speaking of the residue obtained by evaporation with dilute *sulphuric acid* (not *aqua regia*). "With phosphoric irons containing titanium the silica is contaminated not only with iron

but also with titanic oxide and phosphoric acid. The residue may be very nearly white and still contain 20 per cent of substances other than silica." This, it will be seen, is quite different from the quotation given by Mr. Morgan. It is true I did not mention that on dissolving an iron containing titanium, in aqua regia, part of the titanium is obtained in an insoluble form. But Mr. Morgan is over hasty in attributing this omission to my ignorance; as a matter of fact I had known this for years, and as it is mentioned by every writer on the subject I have ever read, it seemed scarcely necessary to repeat it. Mr. Morgan states in the quotation above given, "that part of the titanium remains behind *in combination with the silica*." My own views, as expressed in my paper, were that under the circumstances mentioned the titanium existed in the form of a basic compound of iron, titanium, and phosphoric acid. At present I see no reason to alter this view.

SIMPLE FORM OF FILTER PUMP.

By ROBERT LAW.

A VERY simple and efficacious form of filter pump can be made as follows:—Select a piece of stout glass tube,



3" long and ⅜" bore; fit this with corks, one with two holes, the other with one hole. Now take three pieces of ordinary glass tubing $\frac{1}{10}$" bore, and draw two of them out as shown in Fig. 1; cut the one at *a* and the other at *b*; bend the third piece at an angle of 90°. Insert *x a* and the bent piece through one cork and *x b* through the other, so that *x a* will project inside of *x b*. Attach *x a* to a water supply. On allowing water to run through the apparatus a vacuum will be caused in the tube N, and, if connected as shown in sketch, filtering becomes a great deal more pleasant. I have found this apparatus to work very well: it gives a vacuum = 28·5" of Hg.

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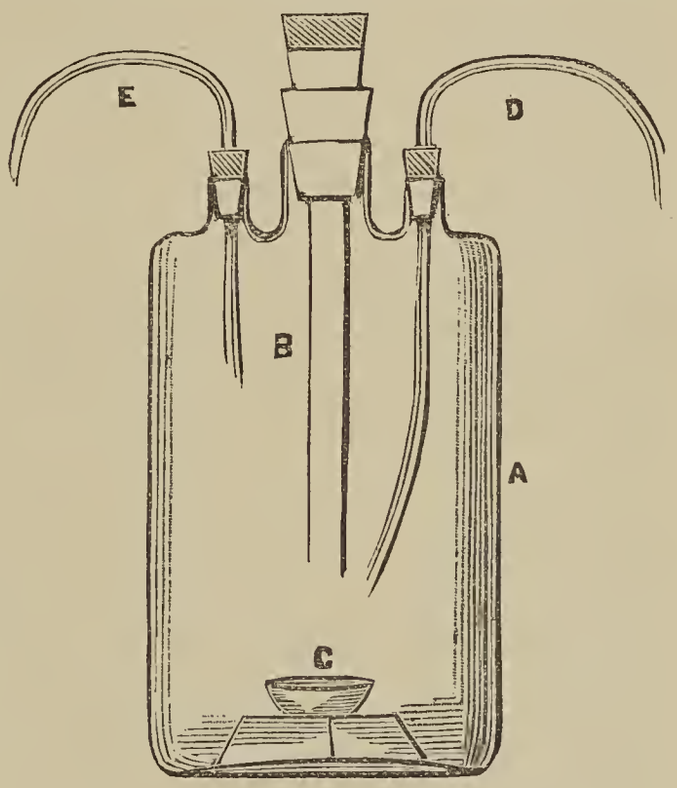
AN APPARATUS FOR PREPARING SULPHUROUS, CARBONIC, AND PHOSPHORIC ANHYDRIDES.

By H. N. WARREN, Research Analyst.

HAVING had occasion to prepare a quantity of sulphurous anhydride, for the purpose of reducing chromates previous to their analysis, I made use of the following apparatus, as represented in the accompanying figure:—It consists of a glass vessel, A, provided with three tubulars, otherwise resembling a large Wolff bottle, the large tube B being provided with a stopper for the purpose of introducing pieces of sulphur from time to time into the small dish, C, intended for its reception, and fed with air by means of the delivery tube, D, thus allowing the stream of gas



caused by the consumption of the sulphur to escape by means of the exit tube, E, to the vessel desired to receive it.

In using the apparatus the sulphur is first kindled by introducing a red-hot wire through the tube B, and replacing the stopper that has been momentarily removed for the introduction of the same. A slight blast is now maintained from the bellows that are in connection with the pipe D until the whole of the sulphur is thoroughly kindled, when a somewhat more powerful blast may be applied. When the apparatus above described is in full working order, from 2 to 3 lbs. of sodium carbonate may be converted into sodium sulphite in less than half an hour, or several gallons of water saturated. I have also, on connecting the apparatus with a powerful refrigerator

obtained in a short time a large quantity of liquid SO_2. It will be found advantageous, however, during the preparation of sulphurous anhydride, to employ a layer of water covering the bottom of the vessel to about 1 inch in depth. Carbonic anhydride and phosphoric anhydride may also be readily obtained in any desired quantity by slight alteration; but in case of phosphorus the air must be allowed to enter only gently, since a rapid current would at all times determine the fracture of the vessel.

THE METHODS EMPLOYED IN THE ANALYSIS OF IRON ORES,

TOGETHER WITH A

SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID.*

By A. A. BLAIR.

(Concluded from p. 235).

O. KORSCHELT (*Dingler's Pol. Jour.*, ccxxv., 158) suggested the use of potassic molybdate instead of ammonic molybdate. He prepared the solution by dissolving 1 part MoO_3 in 1 part KHO and 6 parts water, after cooling adding a solution of ½ part tartaric acid in 2 parts water, and finally 7½ parts nitric acid, boiling and filtering while hot. He dissolved the iron or steel in the smallest possible amount of boiling nitric acid, filtered, and added the heated solution to an excess of the molybdate solution in a capsule, also heated on the water-bath. He filtered on a balanced filter, washed with dilute HNO_3 and then with alcohol, dried at 120° to 130° C., and weighed. The precipitate contained 1·73 per cent P.

Boussingault (*Dingler's Pol. Jour.*, 1872, p. 223) used the fact of the insolubility of phosphate of cerium (pointed out by Damour and Deville) in HNO_3 in the determination of P_2O_5 in iron and steel.

Finkmer (*Deut. Chem. Ges. Ber.*, x., pp. 1638–1641) approved of Sonnenschein's method, and suggested the addition of an increased amount of NH_4NO_3, and the washing of the precipitate with a solution of ammonic nitrate and nitric acid. He washed the precipitate into a weighed crucible, evaporated off the water, heated it over wire-gauze to expel the NH_4NO_3, and weighed the ammonic phospho-molybdate. It contained 3·794 per cent P_2O_5.

E. Riley (*Chem. Soc. Jour.*, 1878, i., 104) recommended most strongly the acetate method, using $MgCl_2$ instead of $MgSO_4$ in his magnesia mixture, and citric acid to keep the Fe_2O_3 in solution. He considered a large amount of citric acid necessary. He allowed the solution to stand over night before stirring, then stirred vigorously, and allowed to stand for twenty-four hours before filtering off the precipitate of $Mg_2(NH_4)_2P_2O_8$. He suggested, also, a combination of the acetate and molybdate methods by dissolving the acetate precipitate in HCl, adding excess of NH_4HO, acidulating by HNO_3, and precipitating by ammonic molybdate, filtering and weighing the phospho-molybdate of ammonia.

For the determination of P_2O_5 in iron ores, iron, and steel there are practically but two methods in general use at the present day—the molybdate and the acetate—unless we consider a combination of the two as a separate method. Each has its ardent admirers, but the general opinion among chemists of experience is, that either method will give accurate results if proper care and skill are used in carrying out the details of the work. I propose to point out those details which require special care in each method, and want of attention to which may cause serious errors in the results. The presence of titanic acid, unless the precautions mentioned in the method given in my report for the determination of P_2O_5 are observed, will be a fruitful source of error in either, and arsenic acid, unless carefully separated, will cause too high results whichever method be used.

1. In the molybdate method the first point to be observed is the destruction of the carbonaceous matter, especially in the case of irons and steel. I first observed this in 1877 in an investigation of Korschelt's method, which is mentioned in a paper by Hunt and Peters (*Metallurgical Review*, vol. ii., p. 365) to whom I communicated the fact in 1878. Finkmer (*Deut. Chem. Ges. Ber.*, x., pp. 1638–1641) mentioned the same thing in the same year, and says, very truly, "0·10 per cent of P in a steel may easily be entirely overlooked by inattention to to this fact."

2. If the solution of the steel or iron in HNO_3 is evaporated to dryness, and the residue is ignited to destroy carbonaceons matter, it must be re-dissolved in HCl, for very often the ignited ferric phosphate is quite insoluble in HNO_3. This requires repeated evaporations with HNO_3 to get rid of HCl, which is considered deleterious by such analysts as Fresenius and Finkmer.

3. Silica must be removed from the solution before adding the molybdate solution, unless the P_2O_5 be finally precipitated as $Mg_2(NH_4)_2P_2O_8$.

4. After adding the molybdate solution, great care must be exercised on two points—the degree of acidity and the temperature of the solution. The phospho-molybdate of ammonia will not precipitate readily if the solution is too acid or the temperature too low, and a continued high temperature or boiling of the solution tends to the precipitation of an excess of molybdic acid with the ammonic phospho-molybdate. The most careful analysts direct that the solution should stand from six to twenty-four hours before filtering, and that the filtrate should always be tested by a fresh addition of molybdate solution.

5. If the P_2O_5 is finally weighed as $Mg_2P_2O_7$ it is very difficult to get rid of the last traces of molybdic acid. After two precipitations as $Mg_2(NH_4)_2P_2O_8$, I have found appreciable amounts of MoO_3 in the HCl solution of the ignited $Mg_2P_2O_7$.

In the acetate method the first point which requires special attention is:—

1. Driving off the excess of SO_2. It is very necessary to do this, as ferric phosphate is soluble in SO_2 and in ammonic sulphite.

2. Both care and experience are necessary in neutralising the deoxidised solution, for all the free HCl must be neutralised, and enough NH_4HO added to precipitate all the ferric phosphate and ferric oxide, and an excess over this should be avoided as tending to obscure the reaction and causing an excess of ammonic acetate, which is deleterious. On the other hand, if all the Fe_2O_3 is not precipitated, there will be loss, for ferric phosphate is soluble in ferric chloride.

3. The precipitate of ferric phosphate and oxide should not be washed much (one washing is ample), as ferric phosphate is decomposed by pure water. My own personal preference is for the acetate method, and for the following reasons:—1. The sources of error are fewer and are more easily guarded against. 2. If the proper precautions are taken in each method, the acetate is the quicker. I have made many determinations (the accuracy of which was afterward proven by other results) in iron ores in twenty-four hours and in steels in forty-eight. 3. There is not the same temptation in the acetate method that there is in the molybdate to take short cuts, which has brought many a young chemist to grief. 4. Experience has shown* that the molybdate method, as practised by many chemists, is not as accurate although it may be shorter than the acetate.

An accurate determination of P_2O_5, by whatever method it is made, requires much skill and not a little practice, and the advocate of one method often makes the other

* From "Mining Industries of the United States."

* E. Riley, *Jour. Chem. Soc.*, 1878, i., 104, besides numerous cases which have come under my own observation.

suffer in comparison, more by reason of his own want of skill in the manipulation of the other method than by reason of any great advantage inherent in his own.

ON THE EFFECTS PRODUCED BY SMALL QUANTITIES OF BISMUTH ON THE DUCTILITY OF SILVER.

By Surgeon-Major J. SCULLY, Assay Master, Calcutta.

(Concluded from p. 234).

III. We have now to consider the best way of dealing with silver tendered for coinage which is proved to contain bismuth; and a few remaining points.

The only experiment on a large scale for refining such silver here, as far as I know, has already been described. The want of success which attended it seemed to be due to the very small amount of base metal in the bullion, for the formation of a slag in which the bismuth oxide could be entangled and removed by skimming, and possibly the reducing action of the plumbago pots used may have added to the difficulty. As it seemed certain, however, that nitre would effect the desired oxidation of the bismuth, some experiments were tried in this direction on a small scale. About 20 troy ounces of silver containing 2·5 per mille of bismuth, and no other metal in appreciable quantity, was melted in a *clay* pot and repeatedly treated with nitre and borax, the bath being skimmed from time to time. After prolonged treatment in this way, the fineness of the silver being three times tested by a dip assay, the report on the silver was raised from 997·5 to 999·2; so that there can be no doubt that bismuth may be removed in this way. But the process, as several experiments showed, is tedious, and of course is attended with a loss of silver which in large operations would be of notable amount. Considering, therefore, that silver containing bismuth has hitherto only been met with at the Mint in bars of high fineness, and that these are not readily refinable by the ordinary process, it would seem as well, if such silver be accepted at all, to deal with the bismuth in it by the plan of *dilution*. The proportion of bismuth any silver contains being ascertained, it may, if convenient, be mixed by melting with sufficient silver free from bismuth, and with copper, so as to reduce the proportion of bismuth in the coinage bars to less than 0·5 per mille, and thus neutralise its injurious effects on the ductility of the bars.

The explanation of small quantities of bismuth being found in refined silver—*i. e.*, silver which has undergone parting for the extraction of the gold which was contained in it—seems sufficiently indicated in the following extract from Dr. Percy's work ("Silver and Gold," Part I., p. 474), where that author is referring to the experience of Dr. Rössler in parting silver;—"Bismuth has been found in nearly all kinds of silver; but in parting by sulphuric acid it is lost *partly in the fine silver* and partly in the slags." The italics are mine. That small quantities of bismuth adhere very tenaciously to silver, when once mixed with that metal by melting, is shown by the following experience:—A quantity of silver containing bismuth, which had accumulated from the laboratory experiments before detailed, was melted, granulated, dissolved in nitric acid, and the silver precipitated as chloride. The silver chloride, after repeated washings, was reduced by heating in a plumbago pot with chalk and charcoal. The resulting ingots, on assay, showed at once that bismuth was still present in them in very appreciable quantity.

It may here be of interest to mention that I have found about 0·7 per mille of bismuth in some old Hindu punched coins, forming part of a treasure trove which was found at Chaibassa, in the Singhbhum district.

The following is a summary of the main results detailed in this paper:—

1. The Indian assay process for silver bullion is, incidentally, a delicate qualitative test for the presence of bismuth in such bullion.

2. The assay process can be readily modified so as to give accurate results in the presence of such proportions of bismuth as are likely to be encountered in practice.

3. Fine silver when alloyed with only 1 per mille of bismuth has its ductility sensibly impaired thereby; and 1 per cent of bismuth is sufficient to render fine silver, or alloys of it with copper down to 906 fine, extremely brittle.

4. Fine silver alloyed with small quantities of bismuth, and silver-copper alloys down to 980 fine when containing small proportions of bismuth, have the remarkable property of being more ductile when rapidly cooled in water after casting than if allowed to cool very slowly, thus resembling bronze in this respect.

5. Coinage bars such as are used in the Calcutta Mint, and with the procedure there adopted for rolling, are quite unfit for coinage, owing to brittleness, if they contain only 3 per mille of bismuth, while if the latter metal forms less than 0·5 per mille of the whole mass the ductility of the bars is not much affected.

In conclusion, I have much pleasure in recording my appreciation of the services of Messrs. J. R. L. Durham and E. Hood, Head and Second Assistants in the Assay Office, in carrying out under my directions many details of the experiments recorded in this paper.

Calcutta, March, 1887.

PS.—June 10th. The experiments detailed in the foregoing paper were completed early in November, 1886, and it was proposed to embody the conclusions formed in an official report to be submitted this year. It was suggested to me, however, that the subject investigated might be of general interest, and I had determined to publish this paper when I noticed in the Chemical News of March 21st, 1887 (p. 137), a short abstract of a paper on "Silver containing Bismuth" by Messrs. Gowland and Koga, of the Japan Mint. I have delayed presenting this paper until I had read the full text of the communication from Japan (*Journal of the Chemical Society*, No. ccxciv., May, 1887, p. 410), and I may now make a few remarks upon it in connection with what I have advanced.

Messrs. Gowland and Koga's very interesting paper to a great extent covers ground which I had not investigated, viz., the want of uniformity in composition of silver bullion containing bismuth. This part of the subject was suggested to me for experiment, as some of my results seemed to show that bismuth mixed with silver by melting and careful stirring does not diffuse itself evenly throughout the solidified mass. But that fact, now proved by Messrs. Gowland and Koga, was of no practical importance to us in the assay and valuation of bullion, seeing that it is an invariable rule now in the Calcutta Mint to pre-melt and assay by a granulated sample *every* kind of bullion tendered to the Mint,—from refined bars 999·5 fine to Mexican dollars. The well-known want of homogeneity in solidified silver-copper alloys, and other contingencies to which silver bullion is subject, render this course imperative for purposes of valuation on any extended scale. The cutting of samples from silver bullion for assay, even if the spot where such samples should be cut has been determined after most laborious investigation, can at best give merely approximate results,—as indeed our authors admit for the case of silver containing bismuth.

With regard to the toughening or refining of silver containing bismuth, Messrs. Gowland and Koga mention that this operation is successfully performed in the Japan Mint by prolonged exposure of the molten metal to the oxidising action of the air, aided in some cases by the use of nitre. This may seem at variance with our experience here, but is probably not so after all. The brittle bullion treated in Japan evidently contained a considerable amount of base metal in addition to the bismuth, the

slags formed in the early stages of the melting consisting chiefly of litharge, &c. What we had to deal with was refined silver 990 fine, and in this case of course it would be more difficult to free the bullion from bismuth than if lead and other base metals were present in sufficient quantity to form a copious slag. But in any case (without, however, venturing to give any authoritative opinion on the subject) I doubt whether the Indian Mints would willingly undertake any considerable refining operations on bullion. The conditions under which these Mints receive bullion are very different from those obtaining in the case of the American and Australian Mints, and the Imperial Mint of Japan. In those countries encouragement has to be given to native mining industries, and hence a good deal of work in the way of purification and separation of metals is undertaken by their Mints. In India practically all the bullion is imported by banks and merchants, from Europe, America, and elsewhere, and tendered to the Mints for coinage at a fixed charge. The Indian Mints may therefore, as in the case of the Royal Mint in London, very properly require that all bullion tendered to them shall be free from taint of brittleness, and so far fit for coinage. It is for the importers to make sure that their purchases are satisfactory in this respect.

As to the amount of bismuth that will render silver brittle, my results seem to be substantially in accord with those of Messrs. Gowland and Koga. They found that pure silver alloyed with only 5 per mille of bismuth was very brittle; the casting, I suspect, was allowed to cool slowly. Coinage bars of 900 fine, containing nearly 14 per mille of bismuth, were brittle and altogether unfit for coinage, as I should have expected. But by special treatment in the way of repeated annealings, some of these bars were rolled down successfully without cracking, although they still could not be used for coinage.

In the other matters treated of in my paper the results obtained will supplement those of my *confrères* in Japan.

OBITUARY.

THE LATE PROF. T. S. HUMPIDGE, Ph.D., B.Sc.

Last week we had to record the death of a chemical veteran, Prof. Bloxam, on the 29th ult., and now we are grieved to chronicle the death, on the following day, of Prof. Humpidge, of the University College of Wales, in the prime of life and promise, at the early age of 34.

Dr. Humpidge did not begin his strictly chemical career until he was twenty-one, having passed the previous seven years of his life in a corn merchant's office in Gloucester, of which town he was a native. But during this time he had been attending the evening classes at the School of Science and Art, and this so successfully that the Science and Art Department offered him a free place at the Royal College of Chemistry, and £50 per annum for two years. With this assistance he went up to London in 1874 and studied for some time under Professor Frankland, who in 1875 selected him as one of the Jodrell scholars. In 1876 he went to Heidelberg, where he worked under Prof. Bunsen. After taking his Ph.D. there he was appointed, in 1878, science master at the De Fellenberg Institute, Hofwyl, near Berne, and in 1879 was elected to the chair of chemistry at Aberystwyth.

At South Kensington he carried out an investigation on the coal gas of the metropolis, and at Heidelberg worked with Mr. W. Burney on yttrium and erbium. But his most important work was performed at Aberystwyth. Whilst there he made very careful determinations of the specific heat, at different temperatures, of specially purified beryllium. He also made determinations of the vapour densities of the chloride and bromide of that metal. And although the publication of his vapour density determinations was somewhat forestalled by that of the work of Nilson and Petterson, his work was still of great importance in helping to settle definitely the moot question of the atomic weight of beryllium, and to show that here again the periodic system was a correct indicator in the classification of the elements.

Later on work was commenced on the accurate redetermination of the specific heats of various metals. But the disastrous fire at the college in July, 1885, not only put an end to this research by the destruction of laboratory, apparatus, and materials, but by the shock it gave his system undoubtedly largely contributed to the development of the disease to which Prof. Humpidge eventually succumbed. After another session's work the break down of the nervous system was so complete that he had to ask for leave of absence from his professorial duties. A year's rest seemed to have done so much that hopes were entertained of perfect recovery at no distant date, but the improvement was only transitory. A few weeks ago he became rapidly rapidly worse again: in a few days he took to his bed, and then the end came on apace, his death occurring from cerebral deterioration.

As a teacher as well as an investigator Dr. Humpidge was most successful, and his loss will be much felt by students, colleagues, and friends. In 1880 he married Fräulein Johanna Ruder, of Oldenburg, and by her had three sons, the eldest of whom died about two years ago.

He was buried with full academic honours in the churchyard at Llangorwen, near Aberystwyth, on December 3rd.

THE LATE C. L. BLOXAM.

A few additional particulars concerning the career and researches of this chemist may not be unwelcome to our readers.

Charles Loudon Bloxam, the son of a London physician, was born March 23rd, 1831. He was a pupil of the King's College School in the years 1842-3, and in 1845 he entered the Royal College of Chemistry, and the next year he was admitted to the position of a gratuitous student. Prof. Hofmann, in his first report to the Council of the College of Chemistry, speaks of him in these words:—"Mr. Bloxam is a youth of 16 years of age, but his zeal and perseverance inspire me with best hopes for his future progress."

In 1849 Bloxam became an Assistant in the Royal College, which he finally left in the year following. In 1854 he was appointed Demonstrator of Chemistry at King's College. In the same year he was elected a Fellow of the Chemical Society. On the death of Prof. Bowman, in 1856, he became Professor of Practical Chemistry at King's College, and in 1870 he succeeded Prof. W. A. Miller in the Chair of Chemistry. From 1855 to 1882 he held the position of Lecturer on Chemistry and Physics at the Royal Military Academy, an appointment which he resigned owing to certain changes in the management of the Academy which he thought to be degrading to Science. He drew attention to the matter in a pamphlet which received some notice at the time.

He communicated the following papers to the Chemical Society:—In 1857, in conjunction with Sir F. Abel, "Contributions to the History of Nitric Acid with reference to the Valuation of Nitre." In 1858, "On the Juice of Beef." In 1860, "On the Action of Boric Acid upon the Carbonates of the Alkalies and Alkaline Earths." In 1861 he contributed papers on "The Application and Electrolysis to the Detection of Poisonous Metals in Mixtures containing Organic Matter;" "On the Crystalline Hydrates of Baryta and Strontia;" and "On the Electrolytic Test for Arsenic in the Presence of that Metal in Certain Reagents."

In 1862 he wrote "On the Amount of Water displaced from Hydrates of Potash, Soda, and Baryta, by Boric and Silicic Acids." The following year the *Journal* of the society contains his researches on the source of

arsenic in commercial sulphuric acid, and on the preparation of that acid free from arsenic. In 1865 he contributed three papers:—"The Action of Chlorine upon Arsenious Acid;" "The Action of Hydrosulphate of Ammonia upon Copper Sulphide, previously precipitated;" on "General Routine of Qualitative Analysis for Metals;" "Qualitative Analysis of Substances insoluble in Water and Metals;" and "Detection and Qualitative Separation of Tin, Antimony, and Arsenic." To his Valuable contributions to the Chemical News we have already referred. The first edition of his "Chemistry, Inorganic, and Organic," appeared in 1866, and his "Laboratory Teachings" in 1869.

NOTICES OF BOOKS.

Proceedings of the Ninth Annual Meeting of the New York State Pharmaceutical Association, held at the Thousand Island Park, June 21st, 22nd, and 23rd, 1887. New York: Elmira.

The first thing we notice in these Proceedings is a list of questions to be answered at the next yearly meeting. One of these calls attention to a spurious glycerin, consisting of a saturated solution of magnesium sulphate with about 15 per cent of glucose. Such a mixture would possess none of the useful properties of glycerin, but it is described as being deceptive in appearance and as having the specific gravity 1·26.

Another query is "What power has filter-paper of withdrawing alkaloids from solution?" It is suggested that analytical determinations, as regards the more important alkaloids, would be of value.

Question 14 reminds us of a piece of information placed in our hands, of which, pending its verification, we have not been able to make use. The query is "What proportion of arsenic do the arsenic complexion wafers of the market contain, and is their use prejudicial to health?" Here, then, we have the implied assertion that arsenical wafers are sold as cosmetics, the only points raised being the exact proportion of arsenic thus introduced, and its possible effects on the human economy. We should like to know whether similar preparations are sold in Britain?

One of the speakers at the general meeting of the Association quoted the wish of an eminent physician that all the quacks could be killed in one day, but added that such a general slaughter would be of no use, since the demands of human nature would raise as large a crop on the morrow.

From a debate on the adulteration of drugs we learn that adulteration is fairly rife in America. From the hesitation to publish the names of the vendors of spurious or inferior articles, we learn that there, as well as in England, the Libel Law is the quack's sword and shield.

Dr. R. G. Eccles has made some interesting experiments on the action of boric acid upon microbia. He finds that as an antiseptic there can be no doubt of its value, whilst as a disinfectant it is worthless and displays no signs of germicidal power.

The question of the alleged purity of ice and ice-water has been very thoroughly sifted, and the ordinary view—though suggested by such eminent authorities as Prof. Tyndall and the late Dr. W. A. Miller—is found to be quite untenable. Ice, from a solution of 0·83 grm. urea per 100 c.c. of distilled water, was found to retain 0·50 grm. of the impurity to the same volume.

When every 100 c.c. contained 1·5 grm. of glucose, the same volume of ice was found to contain 0·96 grm. Arsenic dissolved in ammonia, and then diluted until 1 litre contained 1·78 grms. of the poison, and then frozen, was found to contain 0·48 grm. in ½ litre of ice.

Professor Nichols, in his Report to the Massachusetts State Board of Health for 1882, says (p. 289)—"Freezing is a form of crystallisation, and the general rules apply only so far as inorganic pollution is in question. Ice frozen from water, holding in solution mineral salts, will contain less of these than the water from which it was originally frozen, and by repeatedly dissolving in distilled water and re-freezing nearly all inorganic impurities can in time be eliminated from the ice. But in case of organic pollution the reverse is true. Often the process of freezing may and does concentrate such impurities, so that the ice contains more in a given weight than the water from which it was frozen."

Pathogenic germs, as a matter of course, are not in the least affected by freezing, and thus several epidemics in the United States have been traced to the use of ice, which, if obtained from rivers or lakes into which sewage can penetrate, should always be viewed with grave suspicion. The sewage of Troy and Albany, in which two cities the yearly average of deaths from typhoid fever is 75, flows into the Hudson, whilst most of the New York ice simply comes from the river *below* the same cities.

The volume before us contains much other interesting matter to which space, or its deficiency, does not permit us to draw attention.

CORRESPONDENCE.

TESTING OILS.

To the Editor of the Chemical News.

Sir,—Mr. Allen has pointed out to me that he considers that the last paragraph but one in my article on "Butter Examination," which appeared in the Chemical News, vol. lvi., p. 222, has an offensive reference to himself.

Mr. Allen says that "he regards this paragraph as practically stating that I suppose Mr. Allen's object in recently condemning chloride of sulphur for the purpose of testing oils was that it clashed too severely with the interests of the oil trade, and I protest against Mr. Allen using his position as an ægis for the questionable practice of others.

I wish to say that although Mr. Allen and myself have lately been at variance on certain points in connection with this matter, that I have too high an opinion of Mr. Allen to apply such remarks to him, and I feel sorry that Mr. Allen should have thought that I could allow my judgment to be warped by a spirit of such reckless vindictiveness.

Chloride sulphur has been repudiated, by some people, as being of no use in testing oils, and this remark, I am told, has been backed up by scientific references; it was this knowledge which called for the remark referred to.

To no class of men is the cultivation of a high moral tone more essential than to chemists. No one, more than myself, can wish for promoting a temperate and kindly feeling between those who enter the arena of debate; it is far better to err on the side of leniency than to drift the other way.—I am, &c.,

Thomas T. P. Bruce Warren.

Tamworth Villa, Earlham Grove,
Forest Gate, E,

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cv., No. 20, November 14, 1887.

Condition of Potassa in Plants and in Soils and on its Determination.—MM. Berthelot and André.—In a living plant potassa may be distinguished as existing in

three states—the one easily soluble in water and transmissible by circulation and diffusion; the second not readily transmissible by pure water, but capable of becoming so by the action of acids; the third more resistant, and not readily displaced. The quantity of potassa extracted by acidulated water differs little before and after incineration. But the proportion removed by water alone was much larger before than after ignition. This latter cannot serve as a measure of the quantity which pre-existed in the living plant or in the soil.

On a New Method of Forming Safranines. — Ph. Barbier and Leo Vignon.—Pheno-safranine and its homologues may be obtained by the reaction of various para-amido-azo-derivatives (amido-azo-benzol and amido-azo-toluol) upon the mono-nitro-mono-benzinic carbides in presence of reducing agents.

Action of Sulphuric Acid upon Mixtures of Morphine and Bibasic Acids.—P. Chastaing and E. Barillot.—On dissolving morphine in an excess of dilute sulphuric acid, and evaporating this liquid until white fumes appear, we obtain sulpho-morphide, a body of a variable composition, and which gives a brown product if treated with concentrated alkalies. Other novel compounds are obtained on adding to the above mixture a diatomic and bibasic organic acid, such as the oxalic, the malonic, or the succinic. These compounds are white when dry and freshly prepared; they do not crystallise, and on exposure to air, especially under the influence of light, they turn greenish. They are insoluble in most neutral solvents, sparingly soluble in cold water, but moderately soluble in boiling water. They behave in general like polyvalent phenols.

Journal fur Praktische Chemie.
New Series, Vol. xxxv., Part 8.

On Oxy-stearic Acids of Different Origin.—M., C., and A. Saytzeff.—The oxy-stearic acid at present known belongs to the β-hydroxy-acids, an assumption which agrees with its behaviour on distillation, when it is resolved into water, and a non-saturated acid of the composition $C_{18}H_{34}O_2$, the latter consisting chiefly of solid oleic acid.

The Transferrers of Halogens in the Natural Groups and Periods of the Elements.—C. Willgerodt. —The author gives a table of the transferrers of halogens as arranged in their natural groups and periods. The most suitable elements for the transfer of halogens are gold, aluminium, gallium, indium, thallium, zirconium, tin, antimony, bismuth, tellurium, iodine, and iron.

On Free Thiocyanic Acid and Cyanic Acid and their Combinations with Ether and Alcohols.—P. Klason. — The author describes hydrocyanic acid, anhydrous and hydrated, their preparation and properties, the molecular combinations of hydrogen sulphocyanide with other bodies, and lastly cyanic acid and its combination with ether.

Remarks on the Addition of Ethyl Malonate to Bodies with a Two-fold Carbon Band.—L. Claisen.—A critique on a memoir by A. Michael (*Jour. Prakt. Chem.*, vol. xxxv., p. 349).

On Halogen-benzol-haloids, especially on α-Trichlor-benzol-hexachloride.—C. Willgerodt.—This compound is colourless, not readily crystalline, of a penetrating and very persistent odour, like putrid straw. The melting-point is between 95° and 96°. It dissolves readily in the cold in ether, chloroform, benzol, ligroine, carbon disulphide, and glacial acetic acid; less readily in alcohol.

Part 9.

Contributions to the Chemistry of the Cobalt-ammonium Compounds. — S. M. Jörgensen. — An elaborate study of the luteo-cobalt salts.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Removing Ink Stains.—I have been for many months past decorating an album, and was unfortunate enough to smear one of the leaves with printers' ink. Can you tell me whether there is any chemical that I can use to remove the stain from the paper (it is of fair thickness) without leaving any mark or injuring it?—J.R.W.

MEETINGS FOR THE WEEK.

Monday, 12th.—Medical, 8.30.
—— Society of Arts, 8. "The Elements of Architectural Design." by H. H. Statham.
Tuesday, 13th.—Royal Medical and Chirurgical, 8.30.
—— Institution of Civil Engineers 8.
—— Photographic, 8.
Wednesday, 14th.—Society of Arts, 8. "Commercial Education, by Sir Philip Magnus.
—— Pharmaceutical, 8.
—— Microscopical, 8.
Thursday, 15th.—Royal, 4.30.
—— Chemical 8. "An Apparatus for Comparison of Colour Tints," by A. W. Stokes. "The Sulphonation of Naphthalene," by Dr. Armstrong and W. P. Wynne, B.Sc. "Isomeric Changes in the Naphthalene Series" Nos. I. to IV., by Dr. Armstrong and Messrs. Amphlett, Williamson, and Wynne. "Notes from the Chemical Laboratory of the Yorkshire College, Leeds. (1) The Reduction of Chlorates by the Copper-Zinc Couple. (2) The Oxidation of Oxalic Acid by Potassium Bichromate. (3) A Method of Separating Supernatant Liquids," by C. H. Bothamley. "The Alloys of Copper and Antimony and of Copper and Tin," by E. J. Bell, Ph.D.

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MINERALS.
PROF. A. E. FOOTE, of Philadelphia, will complete filling the orders that he now has in hand Dec. 9th, and will complete packing what remains Dec. 15th. He can therefore fill orders for blowpipe and his systematic collections at the American Exhibition till that date.
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THE CHEMICAL NEWS.

Vol. LVI. No. 1464.

DETERMINATION OF PHOSPHORIC ACID IN CONTAMINATED WATERS.

By Dr. T. L. PHIPSON, F.C.S., Lond., &c.,
Member of the Society of Chemical Industry.

This note is a little supplement to the analyses of waters and observations thereon published by me in the Chemical News in 1878 and 1879, where, among other things, a method of determining urea in contaminated waters was made known. In the present instance I allude to an easy and rapid method of determining phosphoric acid in similar circumstances, which I imagined not long since whilst making a series of water analyses for the Portuguese Government, and found it of considerable service.

It is well to remark that in pure waters, fit for domestic use, I have never found phosphoric acid present except in the *most minute traces*, even in waters from deep wells; and in many mineral waters it can only be determined in the residue left on evaporation. But with contaminated waters it is different; in these phosphoric acid is always present, and can be detected in the water itself by the following means:—

To about a pint of the water a very small quantity of solution of pure potash alum is added, and then a drop or two of ammonia. Without separating the precipitate, the water is rendered distinctly acid by addition of pure acetic acid; the phosphate of alumina remaining is separated, dissolved in nitric acid, and the phosphoric acid determined by the ordinary molybdate test.

By this method very minute quantities of phosphoric acid can be concentrated and isolated, and determined both qualitatively and quantitatively.

London, Dec. 10, 1887.

NOTE ON THE ACTION OF SEA-WATER UPON CAST-IRON.

By CARTER NAPIER DRAPER.

The results of the long-continued immersion of cast-iron in sea-water are well known, and examples may be found in most of the books of reference. The most frequently cited instance is perhaps that related by Berzelius,* of cannon balls which were raised at Carlscrona from a ship sunk for fifty years, and which had become converted through one-third of their mass into "a porous graphitic substance, which became strongly heated when exposed to the air for a quarter of an hour." The chemical change which cast-iron undergoes under these circumstances is usually stated to consist in the removal of the greater part of the iron, the residue consisting of graphite and a graphitic substance, FeC_3.

I have recently been indebted to the kindness of Mr. John P. Griffith, C.E., of the Dublin Port and Docks Board, for a specimen of grey cast-iron which was broken from an old rail taken from a graving slip in the Port of Dublin, and believed to have been laid in 1833. The rail was at about half-tide level, and it may be therefore assumed that it was for twenty-five years immersed in sea-water, and for a like period exposed to the action of the atmosphere. The fragment of iron weighed 557·31 grms., and measured 85 by 52 m.m., with a depth of 20 m.m. On its lateral surfaces it was slightly encrusted with sesquioxide. The upper surface, for a depth of 7 m.m. had been converted into a brown-grey graphitoidal substance, which was without difficulty removed with a knife, leaving the surface of the iron bright and free from any adherent coating. During the operation of removing the easily pulverulent layer, the mass of iron became hot,—not hot enough to cause inconvenience in handling, but hot enough to enable it to be very sensibly warm to the touch after the lapse of half an hour.

The quantity of altered cast-iron thus removed weighed 67·59 grms., and was examined with the following results:—It was wholly attracted by the magnet. Treated with dilute hydrochloric acid it evolved hydrogen, giving a pale green solution of ferrous chloride and a residue of graphite. The carbon was determined by the method of Weyl. The finely powdered substance, with excess of strong hydrochloric acid, was placed in a platinum dish, connected with the positive element of two Smee cells, while a platinum wire terminal from the negative dipped into the liquid. After twenty-four hours the contents of the dish were transferred to a filter, washed, dried, and weighed: 2·66 grms. of substance gave a carbon residue weighing 0·631 grm. = 23·6 per cent of carbon. By the reaction with free iodine abundant evidence of the presence of unoxidised iron (doubtless existing as FeC_3) was obtained.

Dublin, December, 1887.

* *Gmelin's Handbook*, vol. ccxviii

NOTES ON A NEW ZEALAND SULPHUR ISLAND, AND SOME REMARKABLE FORMS OF NATIVE SULPHUR.

By R. W. EMERSON MACIVOR, F.I.C., F.R.G.S., F.C.S., &c.

The wonderful little island known as White Island, in the Bay of Plenty, is part of the crater of a huge conical mountain which has long since been submerged. It lies about 50 miles east of Tauranga, and 20 miles out of the usual track of vessels crossing the bay between Cape Colville and East Cape. Sir J. Hector, F.R.S., the eminent Director of the Geological Survey of New Zealand, who visited the island in 1870, described it as a horseshoe-shaped range of mountains, having an altitude of from 800 to 900 feet. It had much the same shape and height when I explored it some thirteen years later, but at least half of it disappeared into the sea during the violent and disastrous volcanic disturbances in the northern part of the colony a year or two ago.

I cannot describe the island as it is now, and so must confine myself to a statement of what it was like in 1883. Its sides were steep, deeply furrowed, and even precipitous in places, and carried a good deal of scrubby vegetation besides some small but useful varieties of timber. At one place on the south-west side I observed a considerable deposit of guano, which, however, on analysis proved to be of very inferior quality. The island received its present name from the immortal Cook, probably on account of its emitting from its summit more or less dense clouds of white vapour. These clouds contained much free hydrochloric acid, and the atmosphere in the vicinity of the island was in consequence often anything but pleasant to the respiratory organs of those on board of passing vessels. When the barometer was high little or no vapour rose above the encircling crater wall so as to be visible from seaward, but when it was low the clouds often went right up into the air, and could then be seen from a long distance off, even before the island appeared above the horizon.

I landed at Crater Bay, on the south-west side of the island, which was the only place where there was a beach, and where there was a gap in the crater wall by which I could find easy access to the amphitheatre and

hot lake which occupied the interior. The beach consisted of large stones, and indeed boulders of trachytic lava, and extended a few chains from the sea. Beyond this point and within the crater the ground consisted of tufaceous cinter, superficially covered with gypsum. The inside of the crater had a most desolate appearance, as it was utterly destitute of vegetation. The wall was almost perpendicular all round, and of uneven height, being highest on its southern side. The early morning sun, shining through the feathery clouds of vapour which escaped from innumerable fissures all round the top of one side of the wall, produced a very pretty effect, giving the dull rocks the appearance of having an edging of bright silver. The floor upon which I stood occupied about two-thirds of the space within the amphitheatre, being about 40 acres in extent, and the lake—which stretched from side to side of the crater—covered an area of, I should think, 15 acres. On the opposite shore, and also at one end of the lake, active geysers could be seen throwing out steam and hydrochloric acid in great volumes. On our side of the amphitheatre there were no geysers, though the ground was in many places treacherous and perforated with holes, in the bottom of each of which there was a peculiar black acid mud in a violent state of ebullition. Here and there I noticed small fissures from which sulphuretted hydrogen and steam escaped very freely. At the base of the wall, and close to the margin of the lake, there were extensive accumulations of a mixture of gypsum and sulphur. Samples taken from different parts of these deposits were found to contain from 30 to 85 per cent of sulphur. While exploring this part of the amphitheatre I came upon numerous large balls of what at first sight appeared to be solid gypsum, but on breaking them with the aid of a stick they proved to be hollow shells, internally lined with projecting lemon-yellow prismatic crystals of sulphur, which quickly lost their transparency on exposure to the air! Some of these balls, or rather hollow spheres, were as large as old-fashioned bombshells. One or two which I measured had a diameter of 25 c.m. These mineralogical curiosities could not have been thrown from a distance, nor could they have been carried by water, but how they could have been formed *in situ* puzzles me to this day. The only facts I can offer concerning them are—(1) The shell-wall consisted of gypsum and a little sulphur. (2) The atmosphere within the sphere was much warmer than the outer air. (3) The shells did not occur near the lake or in proximity to active fumeroles. And (4) The sulphur found in them was invariably prismatic and transparent. Reason as I may, I can offer no theory to explain their formation.

It may be mentioned that the floor on this side of the lake reaches an elevation of nearly 60 feet above sea-level towards the interior between the lake and the sea, and then falls away to about 20 feet at the margin of the lake.

Before proceeding further it will perhaps be well to say a few words about Lake Hope,—a name given to this remarkable sheet of water by a previous explorer. It was first described by Dr. Roston and Lieut. Edwin, R.N , of H.M.S. *Brisk*, in 1868. These gentlemen state that it had a temperature of 43·3° C., and a uniform depth of 2 fathoms, at about 50 yards from the southern shore. It was then some 15 feet above sea-level. Hector, during his visit, also found the water to have a temperature of 43·3° C., but estimated the height above sea-level at 25 or 30 feet. I found the lake to register 68° C , and to be fairly uniform in depth, as stated by Roston and Edwin, but it was unfathomable near the centre. There could be no question, however, but that the appearance, temperature, and depth of the water were greatly influenced by meteorological and subterranean influences. I was informed by Judge J. A Wilson, of Touranga, an owner of the island and a man of service, that whenever there were unusual disturbances in the distant Hot Lake Country there were sure to be more or less remarkable changes in Lake Hope. Now, when we consider that there are at least 90 miles of land and sea between the places, this observation appears most interesting, and it is in some measure supported by the fact that a great part of the island disappeared during the terrible eruptions in the Lake Country. However, without further reference to this point, I shall return to my own experiences.

The lake, when I saw it, had a muddy appearance over its deepest part, but was blue-green and transparent elsewhere. The atmosphere over it was very irritating, owing to the hydrochloric acid, which came off from the water in abundance, and from the fumeroles near the margin. Two litres of the water were taken for analysis, and when the sample reached my laboratory in Melbourne it was perfectly clear, but had deposited small crystals of sulphate of calcium on the sides and bottoms of the bottles in which it had been put while warm. The crystals were re-dissolved in the water, and the following is the statement of the analysis in 1000 parts :—

Ferrous sulphate	15·254
Aluminium ,, ...	1·350
Calcium ,, ...	3·605
Magnesium ,, ...	0·931
Potassium ,, ...	4·715
Sodium ,, ...	10·033
Aluminium chloride	25·557
Sodium ,, ...	11·950
Silica	0·670
Hydrochloric acid	149·876
Water, &c.	776·059
	1000·000

This water has also been examined by Skey (*Trans. and Proc. N. Z. Instit.*, vol. iii., p. 278). It will be seen that free hydrochloric acid, chloride of aluminium, chloride of sodium, sulphate of calcium, and potash and soda alums are the principal constituents. The bottom of the lake, wherever visible, was thickly covered with oblique prisms of selenite. It may be mentioned that occasional bathing in Lake Hope had a very beneficial effect in some exceedingly bad cases of rheumatism.

The actual production of sulphur and hydrochloric acid in the fumeroles at one end and on the other side of the lake was one of the most beautiful sights I am ever likely to meet with in the whole laboratory of Nature. The fumerole at one extremity of the lake was rather small, but none the less deposited round its orifice bright yellow sulphur at the rate of about one hundredweight per week, and sent forth limitless volumes of hot hydrochloric acid and steam, which, as they ascended, often assumed the form of perfect vortex rings of great size. The hissing, rumbling, and grunting noises were almost deafening, and at irregular intervals there could be heard—"from far in the bowels of the earth"—peculiarly loud reports, as of explosions, which were immediately followed by the projection of large pieces of dark amber-coloured or red sulphur high into the air. The violence with which these projectiles were sent above the surface may be judged from the circumstance that I have seen pieces of sulphur weighing several pounds dashed against the rocks a hundred feet away from the fumerole.

On the side of the lake opposite to that on which I landed a new fumerole had sprung into existence within a few weeks of the time of my visit, and it had in the short time developed into the most extensive on the island. It was shaped like an inverted cone, had steep sides, consisting of a loose mixture of cinter, gypsum, and sulphur, made moist with acid-laden steam, and was about 40 feet deep. Its mouth had been raised about 6 or 7 feet above the surface of the ground, and had a diameter of perhaps 20 feet. The orifice of the fumerole from which the sulphur, steam, and hydrochloric acid came was circular, and did not occur exactly in the bottom of the cone, but rather to one side,—a peculiarity, by the way, of all the fumeroles on the island. Pieces of sulphur were shot to a height of 30 yards in the air.

One peculiarity of the sulphur ejected from the various

umeroles was its variation in colour. The material deposited at the orifices was for the most part pale yellow and opaque, but that which came out in lumps was quite transparent, and ranged from orange to reddish brown in colour. The tint generally became somewhat lighter as the lumps cooled. This darkness of colour I found to be due to selenium, which occurred in some specimens to the extent of 1·75 and 2·1 per cent. About 10 tons of White Island sulphur were sent to Melbourne, and used in vitriol-making, but it was found that the acid obtained from it had a very dirty appearance and deposited a large quantity of selenious matter on standing for a time. From that day the local manufacturers have refused to use the sulphur, preferring to import the Sicilian article.

Close to the fumeroles there were many large holes full of thin, black, boiling mud, which on examination I found to consist of clay, siliceous matter, gypsum, and iron pyrites, suspended in a strongly acid water containing even more mineral matter than the water of Lake Hope. The latter was fed by boiling-hot streams, which rushed down the courses and deep furrows worn in the steep floor of the crater.

The probability is that the sulphur and hydrochloric acid on the island result from the action of sea-water on hot beds of pyrites within the centre of the submerged mountain.

In concluding these notes I may say that the only indications of life on the island were a few rats, which certainly had shown a terrible want of wisdom in selecting such a home. I expect to hear, sooner or later, that the the remains of this "earthly hell" have sunk for ever into the fathomless sea.

ISOMERIC NAPHTHALENE DERIVATIVES.*

Addendum, December, 1887.†

In formulating the theory of the formation of azo dye-stuffs from beta-naphthol I have represented them as hydroxy-azo-compounds, the essential points to which I desired to call attention being the manner in which they were formed, and that the hydrogen atom in the α-position contiguous to the OH-group was displaced. But it is well known that Liebermann has pointed out, and indeed proved, that the beta-naphthol colours are not hydroxy-compounds, and that he has suggested that in their production a change takes place analogous to that which results in the formation of iso-nitroso-compounds, the formula which he has proposed containing the closed chain—

$$\left.\begin{matrix} C.NH \\ C.O \end{matrix}\right\} NX$$

There can be no doubt that Liebermann's contention is, in the main, correct, but the exact form of the subsidiary closed chain and the position of the hydrogen relatively to the nitrogen is not yet established; and it is even conceivable that the dye-stuffs in question are not closed chain compounds, as represented, but that they contain a dyad radicle N.NHX and CO; that they are hemi-quinones in fact. It is noteworthy that the alpha-naphthol colours do exhibit acidic functions, and Liebermann therefore considers that they are hydroxy-compounds, but it is conceivable that hydrogen attached to nitrogen may exercise acidic functions in their case. The further elucidation of these points by the comparative study of naphthol and naphthylamine colouring-matters will be of importance on account of their bearing on the manner in which the colours are formed, and especially on account of their bearing on the constitution of azo colouring-matters generally.

* Second Report of the Committee, consisting of Professors Tilden and Armstrong (Secretary), appointed for the purpose of investigating Isomeric Naphthalene Derivatives. (Drawn up by Professor Armstrong). Presented to the British Association, Manchester Meeting, 1887.

† The Report was inserted in our last issue (Chemical News, vol. lvi., p. 241).

ACTION OF SULPHURETTED HYDROGEN ON SALTS OF COBALT.

By H. BAUBIGNY.

The author shows that the action of small quantities of acetic acid modifies the action of sulphuretted hydrogen upon cobalt sulphate less profoundly than upon nickel sulphate; but if, instead of acetic acid we add sulphuric acid or any of the strong acids, this difference tends to disappear. For both metals no reaction is produced, even after several days at the ordinary temperature, if the weight of free sulphuric acid is the half of that contained in the salt. Still we must operate with solutions containing at least 0·150 grm. of sulphate per litre, for if the proportion of the salt becomes sensibly inferior to that indicated the acidity becomes almost unimportant, and the sulphuretted hydrogen recovers a part of its chemical activity, especially in the case of cobalt, the solution of which is blackened much more rapidly than that of nickel.

We are here, of course, speaking of initial conditions, for in the action of hydrogen sulphide upon a solution of sulphate, neutral to begin with, the acidity goes on augmenting with the duration of the experiment, both with cobalt and nickel, since the quantity of acid set at liberty increases with the weight of the sulphide formed.

After the lapse of ten days only 12 mi.grms. of cobalt sulphate remained in the liquid of the 400 originally employed. The cobalt sulphide intervenes in the reaction, as it is the case with nickel. If in this experiment we remove, after the expiry of a certain time, the sulphide already formed, the reaction stops. This is natural, because in reality we have then the initial conditions of an acid solution of sulphate just as inversely the transformation of cobalt sulphate into sulphide commences and continues progessively if we add to a solution of this sulphate saturated with hydrogen sulphide and acidified with an excess of sulphuric acid, a quantity of the sulphide of metal approximately equivalent to the free sulphuric acid present.

For both cobalt and nickel the conversion of the sulphate into sulphide is the more rapid as the tension of the dissolved hydrogen sulphide is greater, whence it is probable that a rise of temperature should produce the same action on a sulphuretted solution of cobalt as on one of nickel.

In fact a solution of 0·2 grm. of cobalt sulphate in 140 c.c. of water, saturated at 0° with sulphuretted hydrogen, will retain only 0·003 grm. of sulphate after standing for six hours in a closed vessel at 100°. The action is, therefore, very sharply definite. Still, if we compare the results with those obtained with nickel, it is easy to see that the transformation is less perfect in the former case than in the latter. This fact is confirmed by special comparative experiments. Of two solutions, the one of cobalt and the other of nickel, each containing 0·410 grm. of neutral sulphate in 410 c.c. of water saturated at 0° with hydrogen sulphide, and heated in closed vessels, the second alone (nickel) is completely converted into sulphide after standing for six hours at 100°. On connecting this fact with the observation that a solution of neutral nickel sulphate saturated with hydrogen sulphide gives, in the cold, more sulphide after some days than an identical solution of cobalt sulphate under the same conditions, it seems that the cobalt salts are more easily converted into sulphide than those of nickel when the solution is neutral and very slightly acid, whilst an inverse action is perceived when the acidity augments.

If this is the case the differences between the weights of the nickel and cobalt sulphides formed ought to be the more marked on working with solutions of neutral salts richer than those employed already, for the acidity will be proportional to the quantity of sulphate decomposed. Moreover, in one and the same medium the limit of precipitation is reached more rapidly in heat than at the ordinary temperature. Two solutions of cobalt and

nickel sulphates, each containing 1·2 grm. of the salt in 140 c.c. were heated for three hours to 100° in closed vessels after being saturated with hydrogen sulphide at 0°. After this time the mother-liquor from the cobalt still retained 0·041 grm. of sulphate, whilst that of nickel retained only 0·006 grm. of soluble matter. The difference is further intensified if we operate in a medium which has previously been slightly acidulated with sulphuric acid.

The natural consequence of this fact is that to prevent entirely the formation of cobalt sulphide at 100° a quantity of free acid is required relatively smaller than is needed to prevent the decomposition of nickel sulphate, all other conditions being identical in both cases. Whilst 0·4 grm. nickel sulphide, dissolved in 140 c.c. of water saturated at 0° with hydrogen sulphide, and containing 0·515 grm. of free sulphuric acid (*i.e.*, two and a half times the weight of the acid present in the salt) gives, after standing for eight hours in a closed vessel at 100°, a quantity of sulphide corresponding to 0·218 grm. of sulphate, the precipitation of sulphide in an identical solution of cobalt is almost nul.

As for a concentration varying between the limits of 2 to 8 grms. sulphate per litre, a solution of nickel must be mixed with a weight of free sulphuric acid, equal to about five times the acid present in the salt dissolved if it is not to be precipitable by sulphuretted hydrogen at 100°, we see that the limit of the reaction at 100° between the sulphates of the two metals and sulphuretted hydrogen in presence of an excess of sulphuric acid corresponds in nickel to a relatively greater acidity than in cobalt.

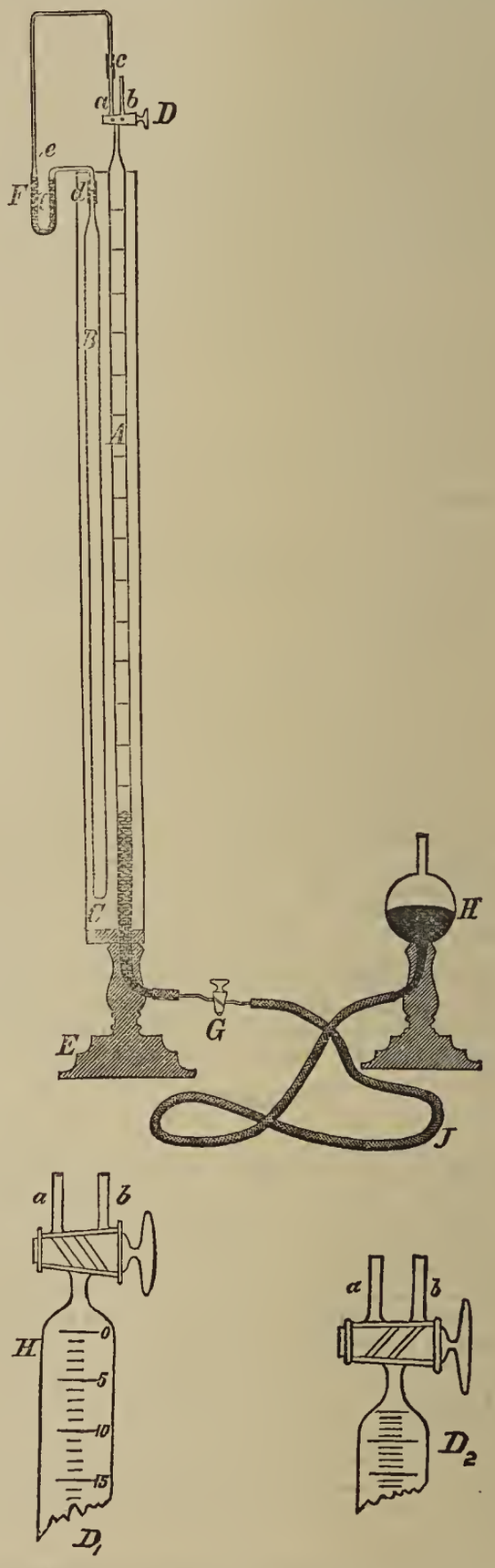
Therefore, if the laws of the conversion of sulphates into sulphides by the action of hydrogen sulphide are the same for cobalt and nickel, at least, generally speaking, cobalt becomes sulphuretted more rapidly than nickel in a neutral or very slightly acid liquid, and when the relative acidity of the liquid increases the progress of the reaction changes; in an acid liquor the nickel sulphate is most readily transformed, though on condition that such acidity is not present at the outset, when it puts a stop to all reaction.

This difference is so decided that we recognise it even in presence of feeble acids. Thus a solution of neutral sulphate of cobalt containing only small quantities of acetic acid, is more rapidly acted upon in the cold, all other things being identical, than a similar solution of nickel. On the contrary, if the proportion of acetic acid contained in the liquid is increased (in which case the action of heat is necessary) the nickel is always the more readily precipitated.—*Comptes Rendus*, cv., p. 806).

W. HEMPEL'S GAS-BURETTE.

This instrument has the advantage of being unaffected by the fluctuating pressure and temperature of the atmosphere. This is effected by connecting the apparatus with a space free from air, but saturated with aqueous vapour. In Fig. 1 is shown such a gas-burette with correction for temperature and pressure. A is an ordinary gas-burette graduated into 100 c.c., and fixed in a heavy cast-iron foot, E. The burette is closed at top by a Greiner-Friedrich glass cock, opening into two capillary tubes, *a* and *b*. By means of two short pieces of caoutchouc tubes the burette is connected with the manometer, F, and the correction tube, B. This correction tube is a simple glass tube melted up at the bottom, and communicating with the manometer, F, by a caoutchouc tube. The burette and the correction tube are enclosed in a wide glass casing tube, C, filled with water. The tube C is open above and closed below by a caoutchouc plug with one perforation. The manometer tube F is about 6 m.m. wide in its U position, but from *e* to *c* it is capillary if mercury is used as the closing fluid, but if water is employed this part is 3 m.m. in width. The burette is connected by caoutchouc tubes with the cock G and the level-ball H.

As a closing fluid there may be used either mercury or water saturated with the gases to be examined. If the



gases are measured moist, which is generally preferable, a drop of water is placed in the correction tube B.

Before putting the apparatus in use it is necessary to ascertain, once for all, the size of the space between *f* and *e* in the manometer tube. This is effected by drawing

any volume of gas into the burette and bringing the three-way cock to the position D, so that the burette communicates with the manometer; by raising or lowering the level-ball the enclosed gas can be readily brought to the same pressure as the gas in the correction tube B. This is the case when the liquid stands at the same height in both limbs of the U-shaped part of the manometer tube, F. The cock G is closed, and the volume of the gas is read off on the scale.

If we then open G again, and lower the level-ball H, the liquid in the manometer tube can easily be drawn up to *c*. If the cock D is then again closed, and the volume of the gas read off on the scale (after previously bringing the gas to the pressure of the atmosphere by raising the level-ball), the difference of the two readings shows the volume of gas sought, between *f* and *e* in the manometer tube. It is here assumed that the volume of air inclosed in B has the external pressure then prevailing which can be easily attained, as otherwise we only need to draw the manometer tube at *d* out of the caoutchouc tube in order to equalise any difference of pressure.

When this constant has been determined we proceed as follows in gas measurements:—We first fill the burette entirely with the closing fluid by raising the level-ball. We then connect the instrument by a capillary tube with the receiver containing the gas in question, and draw the latter in. The three-ways cock must thereby have the position D_2, so that the gas may enter the tube *b*. For measuring, the cock is brought into the position D_1. Then the liquid is brought to the same height in both limbs of the U-shaped part of the manometer tube by raising or lowering the level-ball, and the volume of gas is read off. The true volume of the gas = the reading + the correction. After measuring, the gas is drawn back from the manometer tube into the burette. The absorptions are effected in gas-pipettes, connected with the tube *b* by means of capillary tubes.

The obliquely bored Greiner-Friedrich glass cocks have the great advantage that imperfect closing, in consequence of the formation of grooves, is here quite impossible.

Messrs. Townson and Mercer, of Bishopsgate Street, are the agents in this country for Messrs. Greiner and Friedrich.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, December 1st, 1887.

Mr. William Crookes, F.R.S., President, in the Chair.

Mr. Henry Droop Richmond was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Edward Arthur Andrews, 52, Camden Road, N.W.; Albert Wodehouse Day, Lancing College; Philip Anderson Estcourt, Vyrniew House, Talbot Road, Old Trafford, Manchester; William Gay Forsyth, 2, Granville Place, Glasgow; John Booth Kirkland, Prince's Hill, Carlton, Melbourne; Thomas Atkinson Lawson, Ph.D., B.Sc., 15, Alexandra Road, N.W.; Frederick William Shaw, Heapey Bleach Works, North Chorley.

The following were elected Fellows of the Society:—Messrs. Frank Calder, Horace Woodward Crowther, T. Arthur Dickson, Charles A. Fawsitt, David R. S. Galbraith, Joseph C. A. Hall, James G. Heywood, Cassimir J. Head, Walter Hogbin, Samuel Lees, Jun., David Lennox, Eberhard Luttgen, John McArthur, Angus Mackay, Sydney Martineau, William E. Matthews, John A. Miller, B.Sc., John C. H. Mingaye, Archibald R. Ormiston, Julius Ostersetzer, Andrew W. Taylor, Jose Maria Vargas, John Septibo Ward, Bartlett W. Winder.

The following papers were read:—

86. "*The Alleged Existence of a Second Nitroethane.*" By W. R. Dunstan and T. S. Dymond.

The authors have repeated the experiments of Kissel (*Jour. Russ. Phys. Chem. Soc.*, 1882, 226—230; and 1884, 135—140), who alleges that when the interaction of ethyl iodide and dry silver nitrite takes place at 0°, no ethyl nitrite is formed, but nitroethane together with a new isomeride (b. p. 29—30°), which though possessing certain of the properties of ethyl nitrite, appears to be more closely allied to nitroethane. The authors were unable to isolate any such substance. They show that by carefully fractionating the liquid obtained from the interaction at 0° of ethyl iodide and dry silver nitrite, it may ultimately be resolved into ethyl nitrite and nitroethane, and further, that fractions which distil at low temperatures (below 100°) exhibit the chemical properties of a solution of ethyl nitrite in nitroethane.

87. "*An extension of Mendeléeff's Theory of Solution to the Discussion of the Electrical Conductivity of Aqueous Solutions.*" By Holland Crompton.

The method made use of by Mendeléeff in his paper on "The Compounds of Ethyl Alcohol with Water" (*Chem Soc. Trans.*, 1887, 778), to which the dependence of change of relative density on percentage composition was considered, has been applied by the author, at Dr. Armstrong's suggestion, to the discussion of the electrical conductivity of aqueous solutions, the determinations given by F. and W. Kohlrausch being made use of for the purpose.

The curve obtained in the case of sulphuric acid, representing change of conductivity, with percentage composition $\frac{dk}{dp}$ as depending on the conductivity, was not found to give evidence of the presence of any hydrates in solution. A second differentiation was therefore resorted to and the coefficient $\frac{d^2k}{dp^2}$ plotted out for different percentage compositions. The curve thus obtained has an undoubted rectilinear character and is discontinuous, having breaks at points corresponding to hydrates of the composition $H_2SO_4 \cdot OH_2$, $H_2SO_4 \cdot 2OH_2$, $H_2SO_4 \cdot 6OH_2$, $H_2SO_4 \cdot 24OH_2$, and $H_2SO_4 \cdot 150OH_2$. The presence of all these hydrates, with the exception of that with 24 molecules of water, in aqueous solutions of sulphuric acid has already been recognised by Mendeléeff, who deduced their existence by discussing the change in density of such solutions by the same method that he employed in the case of ethyl alcohol. It is concluded from this that the electrical conductivity of sulphuric acid solutions cannot be a continuous function of the percentage composition, but that it is influenced by certain hydrates existing in the solution, indication of the presence of which is afforded by the second differential coefficient curve.

A certain irregularity exists at each end of the second differential coefficient curve, where the pure compound may be said to first undergo dilution. This is regarded as representing an initiative stage during which the action of the compounds just beginning to be formed has not come fully into play, and the conductivity is influenced by a number of physical actions here probably taking place. It is also pointed out that no break occurs on the second differential coefficient curve corresponding with the maxima observed on the conductivity curve, as the maxima are found to occur at points intermediate between the breaks on the second differential curve. The influence of both hydrates present on the conductivity seems to determine the maximum, which probably represents that the sum of the influence of each is here greatest.

Further confirmation of these facts is obtained by the discussion of other solutions, all of which are found to act in a manner similar to sulphuric acid. In the case of nitric acid there is evidence of the formation of two hydrates, $HNO_3 \cdot 150H_2$ and $HNO_3 \cdot 4OH_2$; and in that of

phosphoric acid of the two hydrates $H_3PO_4 \cdot 8OH_2$ and $H_3PO_4 \cdot 2OH_2$, the presence of the same hydrates being also indicated in each case by Mendeléeff's curve for change of density. In the case of potassium and sodium hydroxides, the hydrates appear to be the same, namely, one with 10, and one with 6 molecules of water.

The fact that the second differential coefficient is a rectilinear function is regarded as evidence that the conductivity is a function of the third order of the percentage composition, $K = A + Bp + Cp^2 + Dp^3$, this function, however, being only continuous between the limits indicated.

88. "*Note on Electrolytic Conduction and on Evidence of a Change in the Constitution of Water.*" By Henry E. Armstrong.

In this addendum to the foregoing paper, the author claims the results in support of the hypothesis which he has elsewhere advocated, that electrolysis is not a mere dissociation phenomenon but depends on an influence which one set of molycules exerts on another set while both are under the influence of the electromotive force. Discussing the first differential coefficient curve, he points out that the influence is exerted almost entirely at two points: in the interval between the acid and the hydrates $H_2SO_4 \cdot OH_2$ and $H_2SO_4 \cdot 2OH_2$; and especially in the interval between the two hydrates $H_2SO_4 \cdot 60H_2$ and $H_2SO_4 \cdot 240H_2$. It is suggested that the comparative smallness of the effect in the former case is due to the acid being present in a "polymerised" less active state, and that the lower hydrates are perhaps also derivatives of a polymer of H_2SO_4. Indication is afforded by a break in the curve of the existence of a compound $2H_2SO_4 \cdot SO_3$. The author is informed by Dr. Messel that on mixing the anhydride and acid, crystallisation first takes place when the mixture has about the composition of such a compound, thus confirming its existence. It is suggested that peculiar breaks in the curve when a small percentage of acid is present with the water, or *vice versâ*, are evidence of a change in the molecular composition of the fluids. Lastly, it is suggested that the electrolysis of fused salts may be supposed to take place in the same way as that of solutions, *i.e.*, that they contain molecules of different orders of complexity capable of influencing each other, and that it is no longer necessary to suppose that there is any fundamental difference in the mode in which the two classes of electrolytes are affected.

Discussion.

The President remarked that the results obtained by Mendeléeff, and now by Mr. Crompton, illustrated the necessity of caution in drawing conclusions from curves which directly represented the results of observation.

Mr. Pickering characterised Mendeléeff's recent communications on density curves as containing a discovery of the highest importance. The acceptance of the hypothesis involved in his conclusions must depend on whether the breaks shown by the differential curves occurred at points exactly corresponding to hydrates of definite composition, and whether different physical properties of the same solution all exhibited breaks at the same points. Mr. Crompton's investigation afforded the first evidence that this latter confirmation was forthcoming. For some months past Mr. Pickering had been examining the curves representing the densities, specific heats, and heat of dilution of salt solutions, and he felt confident that the results would confirm Mendeléeff's views and afford conclusive proof as to the chemical nature of dissolution. He intended also to further examine the heat of dilution of sulphuric acid, and from the heat of dilution he hoped to obtain more definite results than from the study of densities. As far as his present results went, he had obtained evidence in two or three cases of breaks at about $150H_2O$, as well as breaks at a much higher state of dilution. He did not, however, believe in the existence of compounds such as cryohydrates were assumed to be, and thought that such breaks might well be explained, as Dr. Armstrong suggested, on the view that water and liquids in general were made up of molecular aggregates.

Dr. Morley agreed with Professor Pickering that it was much better to make the curves tell their own story in the manner indicated by Mr. Crompton and Dr. Armstrong, than to divide them by the eye into arbitrary sections in the way which had hitherto been usual. He anticipated that the new method would lead to important results. At the same time he did not quite see at what point differentiation should stop: Mendeléeff had differentiated his curves once, Mr. Crompton had performed the operation a second time—why should it not be executed a third or a fourth time? It was obvious that the position of the maxima and minima was greatly changed after each differentiation, and therefore the system of straight lines which most nearly approximated to the curve would be different in each case.

No doubt, if at any time the curve should exactly resolve itself into straight lines, that would be a proper time to stop, but, if only on account of experimental errors, it was not likely that this would often happen. If we knew the law that governed the change of conductivity of a solution whose molecular constitution was not altered by dilution, the problem would be solved; thus if the curve expressing that law were a conic section we should differentiate once, if it be a cubic we must differentiate twice, and so on. For example, the same experimental curve might perhaps be represented, within the limits of experimental error, either by portions of five conic sections, by portions of three cubics, or by parts of two curves of the fourth degree; which representation was to be chosen?

Prof. Ramsay agreed with Dr. Morley's remarks. He asked Mr. Crompton whether any physical meaning was to be attached to the second differential coefficient, or if it was merely found to fit the facts. Commenting on Dr. Armstrong's remarks, he asked to be informed what special views on electrolysis were held by Dr. Armstrong which could be supported by the proof of the existence of complex molecular aggregates. Dr. Armstrong had spoken of such molecular aggregates being urged past each other by the electric current; but of this there would appear to be no proof, for, as far as the speaker knew, there was no proof of the separation of such aggregates to opposite poles during the passage of a current. Moreover, granting Dr. Armstrong's assertion that such transference of molecular aggregates in opposite directions did occur, how is the fact of electrolysis to be explained by the friction of those travelling in opposite directions? Did Dr. Armstrong imagine that the corners of such aggregates were rubbed off?

Mr. Crompton, replying to Dr. Morley's objection that there did not seem to be any reason why a limit should be put to the differentiation when that operation had been performed twice, and that it would be just as reasonable, to proceed with a third or fourth differentiation, and so on, said that a limit to the differentiation would necessarily have to be made according to the nature of the case under investigation and the discretion exercised by the investigator. In the present instance the limit of differentiation is clearly indicated by the agreement of the results obtained with those previously arrived at by Mendeléeff by discussing a totally different physical property. There would obviously be nothing gained by a further differentiation in the present case, for, supposing that operation to be again performed, it would give first a constant, and on repetition zero, or at most leave the errors due to experiment, and those which come in when performing the differentiation. In general it is easy to recognise when this stage is reached, provided that the errors are small, as in the experiments under discussion. In reply to Prof. Ramsay he said that he could not give any physical meaning to the second differential coeffic ent.

Dr. Armstrong said that he could not now usefully reply to the questions put by Prof. Ramsay, as to do so

would involve a lengthy explanation of all that had previously been urged; moreover, his views had been fully stated in documents which were in the hands of the members of the British Association Electrolysis Committee.

89. "*Bismuth Iodide and Bismuth Fluoride.*" By B. S. Gott and M. M. Pattison Muir.

The preparation of bismuth iodide in the wet way, by addition of potassium iodide to a solution of bismuth nitrate, is described. The amounts of decomposition of specimens of bismuth iodide prepared in the wet and dry ways by heating with water are tabulated, and shown to be practically the same.

The preparation of bismuth fluoride by adding potassium fluoride solution to a solution of bismuth nitrate is described, and the properties of this salt are enumerated.

The relative densities of BiI_3, BiF_3, and BiOF are given.

90. "*The Action of Hydrogen Sulphide on Arsenic Acid.*" By B. Brauner, Ph.D., and F. Tomicek.

When arsenic acid is treated with hydrogen sulphide, the precipitate consists either of arsenic pentasulphide or contains in addition arsenic trisulphide and sulphur. The authors find—(1) that when a *rapid* current of hydrogen sulphide is passed into a warm solution of arsenic acid containing chlorhydric acid, the pentasulphide is formed slowly, but completely:—

$$2H_3AsO_4 + 5H_2S = As_2S_5 + 8H_2O;$$

(2) that in solutions of the acid, or when the gas is passed *slowly* into warm solutions of arsenates containing chlorhydric acid, a secondary reaction takes place together with the first chief reaction, but never alone, viz.—

(*a*) $H_3AsO_4 + H_2S = H_3AsO_3 + S + H_2O$;
(*b*) $2H_3AsO_3 + 3H_2S = As_2S_3 + 6H_2O$.

91. "*Note on the Constitution of Mairogallol.*" By C. S. S. Webster.

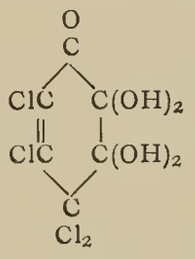
On chlorinating the trihydric phenols pyrogallol and phloroglucinol, I succeeded in obtaining from both the trichloro-derivative (*Chem. Soc. Trans.*, 1886, 423), this stage of the chlorination having previously been overlooked in both cases. Identical results have since been published, without the slightest reference to my work, by K. Hazura and Benedikt (*Chem. Soc. Abstr.*, 1886, 52), and by A. Hantzsch and K. Schniter (*Ber.*, xx., 2033—2040).

The continued action of the halogen operates very differently on the two trichloro-derivatives; in the case of phloroglucinol the benzene nucleus is broken down and chloracetic acids are formed; in the case of pyrogallol there is a union of the C_6 nuclei with formation of C_{18} derivatives, though, from the empirical composition of these it can scarcely be doubted that the double union of the carbon-atoms is resolved at several points. Since the publication of my last note I had been engaged in investigations into the constitution of mairo-gallol and leucogallol, the C_{18} derivatives in question, the results of which have now to a certain extent been anticipated by Hantzsch and Schniter. Their discussion of the constitution of these compounds is based upon one observation only, viz., that they yield trichloropyrogallol as the chief product on reduction by zinc and sulphuric acid. From this and the numerical ratios of the empirical formulæ they arrive at a constitutional formula representing them as a species of quinone chlorides.

The decompositions, which I had studied with the object of elucidating their constitution, are those by water, by heating alone, and by the action of the hyposulphites. On boiling mairogallol with water a rapid decomposition sets in, carbonic anhydride is liberated, and the residual products in solution are oxalic acid and trichloropyrogallol. If sulphurous acid be introduced during the heating a similar decomposition ensues; but the solution contains, in addition to the above-named products, a condensed derivative, which is precipitated from solution by gelatin. On treating mairogallol with sodium hydrogen sulphite in aqueous solution, and adding zinc dust, reduction ensues; the chief product is again trichloropyrogallol. In addition to this amorphous substances are obtained, which may be separated by precipitation with lead acetate and subsequently purified: these resemble the lignocelluloses in giving furfural on distillation with dilute sulphuric acid, and yellow-coloured substitution-derivatives with chlorine, characterised by the magenta reaction with sodium sulphite. On gradually heating mairogallol a sublimate of trichloroquinone and tetrachloroquinone is obtained. The residue is a mixture of a number of products, some of which were isolated in the crystalline form, but in quantity too minute for investigation. Some are amorphous, and precipitated by gelatin from aqueous solution.

Leucogallol when heated at 100° is easily converted into trichloropyrogallol and a product reacting like quinone. Following up the indications of these results, I endeavoured to obtain synthetical products from quinone (chloroquinones) and trichloropyrogallol, but I could obtain no products of combination.

These results undoubtedly confirm the view of Hantzsch and Schniter, that the compounds in question are derived by condensation from a hypothetical molecule represented by the formula—



a substituted quinone in which one of the characteristic oxygens is displaced by Cl_2 and the aromatic linking of the carbon atoms in part resolved.

It is well, however, to bear in mind that this view is based rather upon inferences from the empirical formula than upon actual proof; and it is at least probable that one or more of the C_6 nuclei are more completely resolved, in respect of aromatic constitution, than has been assumed.

With the view of further elucidating the matter, I was engaged at the time of the publication of the paper in question, and still am, in studying these decompositions quantitatively.

In the course of this investigation I had occasion to recrystallise mairogallol from chloroform. Two specimens obtained in this way, after drying at 100°, gave on analysis 52·41 and 52·47 Cl per cent respectively, whereas a specimen re-crystallised from benzene gave 30·34 per cent Cl (calc. $C_{18}H_7Cl_{11}O_{19} = 50·4$ per cent Cl); (calc. $C_{18}H_7Cl_{11}O_{10} : CHCl_3 = 52·37$ per cent Cl). The chloroform appears, therefore, to be retained in molecular combination.

PHYSICAL SOCIETY.

December 10th, 1887.

Prof. W. E. Ayrton, F.R.S., Vice-President, in the Chair.

Mr. E. A. C. Wilson and Mr. W. E. Sumpner, B.Sc. were elected members of the Society.

Mr. H. G. Madan described the "*Optical Properties o Phenyl-thio-carbimide.*"

This body, derived from aniline, is a colourless liquid, density 1·35, and of high boiling-point, 222° C. The refractive indices for the A and G lines are 1·639 and 1·707 respectively. It is thus seen to be a highly refractive liquid, and to have about the same dispersive power as carbon bisulphide, whilst its use in prisms is unattended by many of the risks and inconveniences experienced with

carbon bisulphide. The dispersion at the blue end of the spectrum is very marked. Being less mobile than carbon bisulphide it is less affected by convection currents. The "refractive equivalent" calculated from its chemical constitution differs considerably from the observed value, and this difference the author believes due to the presence of the phenyl radicle and sulphur atom. A polarising prism had been made on Jamin's plan, but using phenyl-thio-carbimide, as the liquid gives a fairly wide angular field (about 25°).

Mr. Hilger stated that there was no great need of liquid prisms now, for very dense flint-glass could be obtained with mean index of about 1·8. Dr. Perkin has recently supplied him with Canada balsam perfectly colourless, and which does not tarnish the polished faces of spar; hence one of the greatest objections to the use of Canada balsam in spar polarising prisms has been removed.

Dr. Gladstone pointed out that the constants for the phenyl radicle and for sulphur atoms had been determined, and thought the calculated "refractive equivalent" obtained by including these would be much nearer the observed value than the one given by Mr. Madan.

"*On the Recalescence of Iron.*" By Mr. H. Tomlinson.

If an iron bar which has suffered permanent strain be heated to a white heat and allowed to cool, the brightness at first diminishes and then reglows (recalesces) for a short interval. Under favourable circumstances as many as seven reglows have been observed during one cooling. Generally two decided ones are observed, one between 500° and 1000° C., and the other below 500° C. The effects the author believes due to "retentiveness" of the material, somewhat similar to the causes of residual magnetism and residual charge of a Leyden jar.

A table of experimental results, giving the torsional elasticity and internal friction at different temperatures, for iron wire, showed sudden increases in internal friction at temperatures of about 550° and 1000° C. The table also shows that the torsional elasticity slowly decreases as the temperature increases, whereas the internal friction increases enormously. This explains why bells cease to emit musical notes when heated.

The author finds that the recalescence at the higher temperature is not appreciably accelerated by mechanical vibration, such as hammering, &c., but those occurring at lower temperatures are greatly influenced by such treatment and by magnetic disturbances.

Prof. Forbes believed the explanation of recalescence given by himself about 1873 is sufficient to account for the effects observed. This explanation postulates a sudden increase in thermal conductivity about the temperature at which recalescence occurs, which permits the heat from the inside to reach the outside more readily, and thus raise the temperature of the surface. The subsequent reglows observed by Mr. Tomlinson he believes due to convection currents of air.

Prof. Rücker suggested that calorimetric experiments might determine which view was the true one; and Prof. Ayrton thought the question might be decided by having two half-round bars, nearly in contact at their flat sides, heated up and allowed to cool, and noting whether any sudden change in the bending of each bar (due to unequal temperatures at the inner sides and outer sides) took place about the critical temperatures.

"*On the Rotation of a Copper Sphere and of Copper-Helices when freely suspended in a Magnetic Field.*" By Dr. R. C. Shettle.

The author exhibited the apparatus with which his experiments "On the Supposed New Force" were made, the results of which were published in *The Electrician* (vol. xix.). Dr. Hofford has recently made similar experiments, using brass discs, and his results seem to point to "diamagnetic non-uniformity" of the discs as the cause of the phenomena he observed.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, December 5, 1887.

Warren de la Rue, Esq., D.C.L., F.R.S., Manager and Vice-President, in the Chair.

The following were elected Members:—Victor Horsley F.R.S., F.R.C.S.; Mrs. Victor Horsley; George Lindsay Johnson, M.B., M.A., F.R.C.S.

The following Lecture Arrangements were announced:—

Sir Robert Stawell Ball, LL.D., F.R.S., Royal Astronomer of Ireland.—Six Lectures (adapted to a Juvenile Auditory) on "Astronomy: The Sun, Moon, Planets, Comets, and Stars." On Dec. 27 (Tuesday), Dec. 29, 31, 1887; Jan. 3, 5, 7, 1888.

George John Romanes, M.A., LL.D., F.R.S.—Ten Lectures, "Before and After Darwin." On Tuesdays, Jan 17 to March 20.

Hubert Herkomer, M.A., A.R.A., Slade Professor of Fine Art in the University of Oxford. Three Lectures on Thursdays, Jan. 19, "The Walker School; Jan. 26, "My Visits to America;" Feb. 2, "Art Education."

C. Hubert H. Parry, M.A., Professor of Musical History and Composition at the Royal College of Music.—Four Lectures on "Early Secular Choral Music," from the Thirteenth Century till the beginning of the Seventeenth. (With Illustrations.) On Thursdays, Feb. 9, 16, 23, March 1.

The Rev. W. H. Dallinger, LL.D., F.R.S.—Three Lectures on "Microscopical Work with recent Lenses on the least and simplest Forms of Life." On Thursdays, March 8, 15, 22.

The Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S. Seven Lectures on "Experimental Optics" (Illustrated by Electric Light). On Saturdays, Jan. 21 to March 3.

William Archer, Esq. Three Lectures on "The Modern Drama: French, Scandinavian, and English." On Saturdays, March 10, 17, 24.

OBITUARY.

THE LATE AUGUST STROMEYER.

We have to notice the sudden death of August Stromeyer, which took place on November 21st, whilst he was engaged in a weighing operation in his laboratory.

From the *Chemiker Zeitung* we learn that the deceased was born at Limmer, near Hanover, July 7th, 1807. He entered the University of Göttingen in 1825 with the intention of studying law, but at the end of the first term he turned his attention to the natural sciences, and especially to chemistry. In 1828 he went to Paris to continue his studies under Gay-Lussac, Thenard, and Dumas. In 1832 he removed to London, and subsequently held the position of assistant to Prof. Clarke at Aberdeen. In 1834 he became manager of a manufactory of chrome products in Norway, where he developed the conversion of the chrome-iron of Röraas into chromium disulphate. In 1852 he left Norway on account of his health, and returned to Hanover, where he spent the rest of his life in chemical research, especially of a technical character. His most important investigation are to be found in *Liebig's Annalen*, though a number of brief communications appeared in the *Zeitschrift des Gewerbe-Vereins für Hanover*, and in the *Wochenblatt für Handel und Gewerbe.*

The Anilides of the Glucoses.—M. Wassily-Sorokine.—The author has succeeded in preparing the crystalline anilides of galactose, levulose, and dextrose.—*Moniteur Scientifique*, Sept., 1887.

NOTICES OF BOOKS.

The Saliva as a Test for Functional Disorders of the Liver. By Samuel Fenwick, M.D. London: J. and A. Churchill.

It is well known that the human saliva contains potassium sulphocyanide. The proportion of this salt is, according to the author's observations, very variable, and these variations correspond so closely with changes in the action of the digestive organs that a quantitative examination of the saliva may furnish the physician with valuable indications. The method of determination adopted is colorimetric. As a standard a solution of iron sulphocyanide of definite strength is prepared, and is graduated by successive dilutions so that each solution is exactly three-quarters of the strength of the one preceding. These standard solutions are then placed in a series of small flat bottles, like those used for spectroscopic purposes. Each specimen of saliva examined is first mixed with a definite quantity of the tincture of ferric chloride, filtered through cotton-wool, placed in a bottle of equal size and thickness, and compared with the graduated standards. A preliminary trial showed that in healthy persons the colour produced varied considerably, though in the majority a normal point was recognised. Observations were then made on the patients of the London Hospital.

The observations here made have chiefly a medical interest, but we may note, as the best-established result of this interesting inquiry, that the quantity of sulphocyanide was below the normal "whenever the digestive organs are unable to supply nutriment sufficient to meet the requirements of the system."

Experimental Chemistry for Junior Students. By J. Emerson Reynolds, M.D., F.R.S., F.C.S. Part IV. Chemistry and Carbon Compounds, or Organic Chemistry (with an Appendix on Ultimate Organic Analysis). London: Longmans, Green, and Co.

It is difficult to form a fair estimate of any work without having the opportunity of examining it as a whole. Dr. Reynolds, in the part before us, seeks "to harmonise the natural with the systematic study of carbon compounds." He considers that "the best corrective of hard mechanical conceptions of molecular structure is the chemical changes that can be induced by variations of experimental conditions." In twenty-two chapters he takes the student through the totality of classes of compounds from wood spirit to the alkaloids.

To survey all these groups of substances within the compass of 380 small pages requires great condensation. Accordingly the utmost concision in style has been aimed at. We find that the author does not, like many authorities, place theobromine and caffeine among the alkaloids, but refers them to the derivatives of urea. The space given to the aniline colours is small when compared with that devoted to artificial indigo, which, interesting enough as a laboratory experiment, would have had certain very unpleasant results if it had proved a commercial success. The author also notices favourably the search for substitutes for quinine. The author considers the ordinary methylated spirit "useless for drinking." So it was intended to be, but unfortunately workmen in establishments where it is used often drink it, even when it contains the further addition of shellac. The circumstance that the wood-spirit added to the ethylic alcohol must be impure renders this spirit much less of a boon to chemical manufacturers than it is commonly supposed. The German Government now allows spirit for industrial purposes to have an addition of only 3 per cent of a mixture of two parts wood-spirit and one part of pyridine bases.

The work before us is a good summary of organic chemistry.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cv., No. 18, October 31, 1887.

New Fluorescences with well-defined Spectral Rays.— Lecoq de Boisbaudran.—Gallium oxide, strongly ignited, gives fluorescences generally less bright than those due to alumina, but the results are of the same order. Gallia containing 2 per cent of samaria gives a fine fluorescence, much less intense and more red than that of alumina and samaria. The fluorescent rays of alumina charged with praseodymium gain in lustre when the action of the induced current is prolonged.

Researches on the Application of the Rotatory Power to the Study of Compounds formed by the Action of Ammonium Molybdate upon Solutions of Tartaric Acid.—D. Gernez.—In experiments on the action of tartaric acid upon sodium and ammonium molybdates, the compounds corresponding to the maximum rotation contain, in case of the former salt, 1 equivalent, and in the second only $\frac{1}{2}$ equivalent, but this discrepancy disappears if we consider that ammonium molybdate is tribasic.

Action of Sulphuretted Hydrogen upon the Salts of Cobalt.—H. Baubigny.—(See p. 253).

On the Ammonium Phosphites.—L. Amat.—Three ammonium phosphites have been described by Wurtz. The mono-metallic phosphites of the alkaline metals are unknown, the only ammonium compound described being the di-ammonium phosphite. The author has obtained a salt to which he gives the formula $(PO_3HO)NH_4O,HO$.

The Double Silver-Potassium Carbonate.—A. de Schulten.—The compound obtained on pouring a little silver nitrate into a strong solution of potassium carbonate mixed with potassium dicarbonate is a white amorphous precipitate which, on standing, becomes transformed into white microscopic crystals, which become yellow, and are decomposed if the liquid in which they are formed is diluted. The formula of the compound is $AgKCO_3$.

Certain Salts of Aniline.—A. Ditte.—This paper contains a description of aniline molybdate, tungstate, vanadate, iodate, chlorate, and borate.

Formation of Normal Amylic Alcohol in the Fermentation of Glycerin by Bacillus Butylicus.— E. C. Morin.—This paper contains an experimental verification of the fact announced in its title. It is remarked that all the products of this fermentation are normal.

Bulletin de la Société d'Encouragement. Series 4, Vol. ii., No. 19, July, 1887.

Manufacture of Soda from Sodium Sulphate by Means of Carbon Monoxide and Dioxide.—This process, devised by Kayser, Young, and Williams, of Buffalo, is founded upon the following reaction—

$$Na_2SO_4 + CO_2 + CO = Na_2CO_3 + SO_2 + CO_2.$$

The temperature at which the two gases act upon the salt cake is a dull cherry red; sulphurous acid escapes and is utilised for converting salt into salt-cake by the injection of oxygen and steam, as in the Hargreaves process. The operation, which is conducted in retorts, is continuous without discharge of the sulphate, and is completed by the admission of the mixed carbon gases, which are incorporated with the masses by means of an aspirator. The mixture of the two gases, in equal equivalents, but with a slight excess of carbonic acid, is generated in a special furnace, which produces in the lower part carbon monoxide, and in the upper part carbon dioxide (*Dingler's Polyt. Journal*).

Journal fur Praktische Chemie.
New Series, Vol. xxxv., Part 9.

On New Reactions with Sodium Acetacetic- and Sodium Malonic Ethers.—A. Michael.—The author examines the behaviour of these ethers with the aldehyds, the ketones, phenyl-isocyanate, the anhydrides of bibasic acids, the inorganic anhydrides, the phenoles, sulphur, urea, the sulph-ureas, and aldehyd-ammonia.

The Action of Chlorine upon Organic Sulpho-cyanides.—J. W. James.—In connection with his investigation of ethylene-chlor-sulphocyanide the author resumed this question formerly studied by Cahours and Riche, and examined the action of chlorine upon methyl and ethyl sulpho-cyanides in the hope of obtaining chloro-sulphocyanides. But the radicle cyanogen was at once eliminated by chlorine as cyanogen chloride.

MISCELLANEOUS.

The Chair of Chemistry at King's College.—We are pleased to announce that the Council have elected Dr. J. Millar Thomson to the Chair of Chemistry vacant through the death of Prof. Bloxam. Dr. Thomson's connection with the College began with the post of Junior Demonstrator in 1871, and the Senior Demonstratorship in 1879, which he has held up to the present time.

Royal Institution of Great Britain.—The following are the probable arrangements for the Friday Evening Meetings before Easter, 1888:—

Jan. 20th. The Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., Professor of Natural Philosophy at the Royal Institution.—"Diffraction of Sound."

Jan. 27th. Joseph Thomson, F.R.G.S., Gold Medallist of the Royal Geographical Society.—"The Exploration of Masai-Land."

Feb. 3rd. Frank Crisp, LL.B., B.A., V.P. and Treas. Linn. Soc., Sec. R.M.S.—"Ancient Microscopes."

Feb. 10th. W. H. Preece, F.R.S.—"Safety Lamps in Collieries."

Feb. 17th. Sir Henry Doulton.—"Some Developments of English Pottery during the last Fifty Years."

Feb. 24th. The Very Rev. G. Granville Bradley, D.D., Dean of Westminster.—"Westminster Abbey."

March 2nd. C. Meymott Tidy, M.B., F.C.S.—"Poisons and Poisoning."

March 9th. Leslie Stephen, M.A.—"S. T. Coleridge."

March 16th. John Murray, Esq.—"Structure, Origin, and Distribution of Coral Reefs and Islands."

March 23rd. Sir Frederick Bramwell, D.C.L., F.R.S.

MEETINGS FOR THE WEEK.

MONDAY, 19th.—Medical, 8.30.
TUESDAY, 20th.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
WEDNESDAY, 21st.—Geological, 8.
—— Meteorological, 7.
THURSDAY, 22nd.—Royal, 4.30.
FRIDAY, 23rd.—Quekett Club, 8.

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TECHNICAL CHEMISTRY.—A Course of Lectures on the Chemistry of OILS (Mineral and Vegetable) and FATS, by Dr. A. K. MILLER, Assistant in Research Laboratory, will commence on Monday, January 23rd, at 4 p.m. Fee for the Course, £1.
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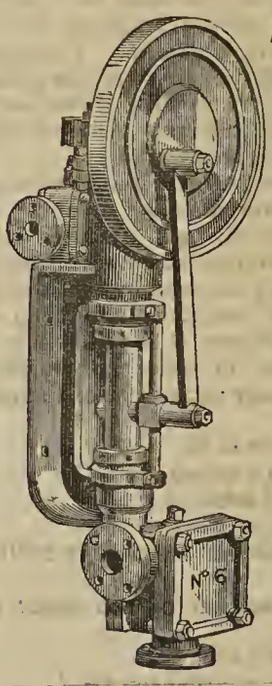

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THE CHEMICAL NEWS.

Vol. LVI. No. 1465.

A DELICATE THERMOMETER SUITABLE FOR LECTURE PURPOSES.

By SYDNEY YOUNG, University College, Bristol.

In a lecture recently delivered to the Bristol Naturalists' Society I wished to show the existence of the point of maximum density of water by means of a closed glass bulb containing such a quantity of mercury that it would sink at 0°, float at about the point of maximum density, and sink again at higher temperatures. (It may be mentioned that owing to the expansion of the glass the apparent point of maximum density is about 6° instead of 4°).

In order that the changes of temperature of the water might be made apparent to the audience a thermometer was required with a stem of internal diameter sufficiently great to allow of the liquid within the tube being seen at distance, and yet with a bulb of moderate dimensions. An air thermometer with a large bulb would answer the first of thes requirements, but not the second. An air thermomet · f a form commonly employed to show the expansion c air with rise of temperature gives, however, very good results when a volatile liquid, such as ether, is substituted for mercury or sulphuric acid, for then, in addition to the expansion of the air, we have the increased vapour pressure of the liquid. The apparatus constructed is shown in the diagram. The cylindrical tube containing air confined by ether has an internal diameter of 17 m.m., that of the narrow tube being 2·8 m.m. The length of the cylinder is 130 m.m., and the length of the tube above the cylinder about 700 m.m. The wider tube above this is sufficiently large to contain the ether which is expelled when the temperature rises to about 24°.

As most colouring matters are insoluble in ether, it was ound convenient to add a little absolute alcohol; aniline red dissolves in this mixture, giving a coloured solution, which is visible at a long distance, and the delicacy of the nstrument is not very greatly reduced by the alcohol.

Knowing the volume of air at 0° and then vapour pressures of ether at each degree, it is possible to calculate the rise of the column of ether (when the pure substance is employed) for any increment of temperature starting from 0° C.

Let the barometric pressure = B.
" volume of air (and vapour) at $t°=V_t$.
" vapour pressure of ether at $t°=\pi_t$.
" pressure of the air at $t°=P_t$.
" pressure of the column of ether in millimetres of mercury $=p_t$.
Let the area of a cross section of the ether in the cylinder = A.
Let the internal area of the tube = a.
" rise of the column of ether for $t°=l$.
" specific gravity of ether $=s'$.
" specific gravity of mercury $=s$.

Then for the pressure on the surface of the ether in the cylinder we have the equations :—

at 0°—

$$P_o + \pi_o = B + p_o \text{ or } P_o = B + p_o - \pi_o$$

and at $t°$—

$$P_o \times \frac{273+t}{273} \times \frac{V_o}{V_t} + \pi_t = B + p_o + \frac{s'}{s}\left(\frac{V_t - V_o}{A} - \frac{V_t - V_o}{a}\right)$$

$$= B + p_o + (V_t - V_o).\frac{(A+a)s'}{A.a.s}$$

For $\frac{(A+a)s'}{A.a.s}$ write α.

Then—

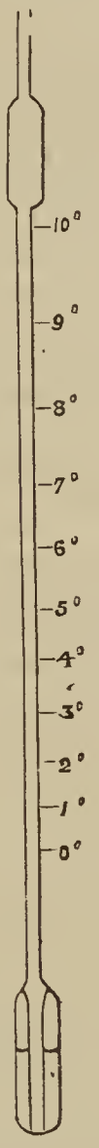
$$V_t^2 + V_t\left(\frac{B + p_o - V_o\alpha - \pi_t}{\alpha}\right) = \frac{V_o \times P_o \times (273+t)}{273\,\alpha}$$

from which V_t may be calculated.

The rise of the column of ether will be—

$$l = \frac{V_t - V_o}{a}$$

It is more convenient, however, to construct the scale by immersing the cylinder in water at various temperatures, noting the height of the column at those temperatures. By plotting these results a curve may be constructed from which the heights of the column at each



degree or fraction of a degree may be read. A paper or cardboard scale may then be constructed with very little trouble.

The indications of the instrument are affected by changes of the barometer, and for accurate work it would be advisable to connect the open end of the tube with a reservoir of air kept at a constant pressure. The delicacy of the instrument might be greatly increased by reducing the pressure of the air.

An idea of the results obtainable may be gathered from the following data, which refer to the instrument actually constructed in which, as already mentioned, a mixture of ether and alcohol was employed.

Total rise of column or 10° C. = 510 m.m.
Rise of column for increment of 1°—
from 0° to 1° = 40 m.m.
" 9° to 10° = 82 m.m.

ON A NEW METHOD OF EXAMINING BUTTER.

By THOMAS T. P. BRUCE WARREN.

In making a quantitative examination of oleo-margarine I found, after separating out the cotton-seed oil, the residue exhausted with carbon disulphide contained cocoa-nut oil and animal fat.

The oleo-margarine was so entirely free from the smell and taste peculiar to cocoa-nut oil that I feel inquisitive as to what could have been added to have so completely masked its smell and flavour: when separated from the cotton-seed oil its smell was most decided; the firmness of the oleo-margarine was due in a great measure to cocoa-nut oil.

I thought it would be interesting to examine the action of sulphur chloride on this oil. When cocoa-nut oil is dissolved in carbon disulphide and sulphur chloride added, in the same way as previously recommended, it behaves like butter, but on evaporating the carbon disulphide it turns much darker in colour. It does not turn cloudy, and dissolves completely in CS_2. A mixture was made of 3 parts cocoa-nut oil and 1 part cotton-seed oil, and treated in exactly the same way as the cocoa-nut oil; it kept perfectly bright and clear.

I find that the addition of a certain quantity of cotton-seed oil conceals the taste and smell of cocoa-nut oil; but the strong rancid odour of the animal fat which separates from the oleo-margarine containing these oils is very pronounced, especially if kept in a warm place for a few hours.

The following will explain the application of this reagent for quantitative results:—

	Grammes.
Weight of oleo-margarine taken	5·76
,, cotton-seed oil added	5·24
,, residue (after treatment with sulphur chloride), &c. ..	7·74
,, due to cotton-oil added ..	5·67
,, increase due to cotton-oil in oleo-margarine	2·07
,, cotton-oil actually present in oleo-margarine	$\frac{5·67}{5·24} \times 2·07$

= 1·91 grammes = 33·3 per cent.

Two experiments with cotton-seed oil alone, as used in this analysis, gave solid residues within 5 per cent of each other. This difference is much greater than need be incurred after a little practice.

The substance washed out with carbon disulphide was evaporated, and every trace of disulphide removed. Water was added to remove the soluble portion and to decompose any free chloride present, when a dark altered oil or fat floated on the surface, and a white adherent fat stuck to the sides and bottom of the flask; evidently this substance had not been acted on by the chloride. It was in hard white tufts, and smelt strongly of cocoa-nut oil.

Cocoa-nut oil, in presence of most oils and fats, is not so easily acted on by sulphur chloride, unless in large excess. The altered oils and fats appear to impede the solubility of cocoa-nut oil; hence it is quite easy to recover, from the experimental mixture of cocoa-nut and cotton-seed oils, the cocoa-nut oil perfectly white and solid. The procedure was in all respects identical with that given for the quantitative results obtained for oleo-margarine.

This portion of the subject is sufficiently interesting and novel, that I hope to deal with it more fully on a uture occasion.

A fact which adds importance to this method of testing is that, if cotton-seed oil or any similarly affected oil be added to oleo-margarine or pure butter, the well-washed solid product obtained is coloured by a portion of the animal fats, which is so far pronounced that no difficulty can arise in deciding whether the animal fats are those belonging to pure butter or whether they belong to certain soft fats or oleins.

ON THE DETERMINATION OF ARSENIC AS THE PENTASULPHIDE.

By LeROY W. McCAY.

In 1878 Bunsen,* in an article upon the separation o antimony from arsenic, showed that by treating an acidified solution of arsenic acid kept alternately hot and cold for a long time, with an excess of sulphuretted hydrogen and permitting the whole to stand for a day, the arsenic was completely precipitated as the pentasulphide. He recommends this sulphide as an excellent form in which to determine arsenic.

I have of late been experimenting a good deal in connection with the conditions regulating the formation of the highest sulphide of arsenic, and have obtained the same results as those obtained by Bunsen. The precipitate obtained by passing a stream of sulphuretted hydrogen through the acidified solution of an alkali arseniate is undoubtedly pentasulphide of arsenic.†

Further, I have discovered a new and rapid method for preparing the sulphide by the action of sulphuretted hydrogen upon arsenic compounds, whereby it is obtained in a state of great purity. Aside from its theoretical importance, the method is of immediate value in its bearing upon the quantitative determination of arsenic. The principal objection to the Bunsen method lies in the long time and large quantities of sulphuretted hydrogen gas necessary to effect a complete separation. Chemists who have had any experience in the matter are well aware o how annoying the sluggish precipitation of arsenic by sulphuretted hydrogen from an arsenic acid solution can be.

It will therefore doubtless prove a relief to many to know that a complete precipitation of the arsenic in the form of the pentasulphide is possible in one hour.

Some time ago I published in the Chemical News (vol. li., No. 1320, March 13, 1885) an article upon the reduction of arsenic to arsenious acid by means of strong sulphurous acid, the reduction being accomplished in hermetically sealed bottles, and at a temperature corresponding to that of a boiling water-bath. In a subsequent paper, which appeared in *American Chemical Journal* (vii., p. 373), I showed how the idea could be made the basis of a method for estimating arsenic with great speed and accuracy.

Lately, while engaged in making some determinations of arsenic according to Bunsen's method, the thought struck me that perhaps the long and disagreeable precipitation of the arsenic might be avoided and the separation be easily and rapidly accomplished by making use of the same device employed in reducing arsenic to arsenious acid. A single experiment confirmed my expectations; the precipitation of the element was complete in one hour.‡ Indeed, the bottle had hardly been in the boiling bath a minute before the yellow pentasulphide commenced to come down. The bottle used in all my experiments has a capacity of about 200 c.c. The stopper and neck of the bottle were treated with a little fine emery powder, so as to produce a perfectly air-tight joint. By wetting a small piece of cloth, stretching it down tightly over the stopper, and tying the ends firmly to the sides of the neck of the bottle with a piece of cord also wetted, the danger of the stopper being thrown out during the heating is rendered very slight. I have generally thrown a piece of wire gauze over the bath during each experiment, but this is really

* *Ann. d. Chim.*, cxcii., 305.

† This is in direct opposition to the statements of Ludwig, Wackenroder, H. Rose, and Fuchs.

‡ See my preliminary note in the Chemical News, vol. liv., p. 287.

unnecessary, as I have never yet had a bottle broken by the internal pressure.

A saturated solution of sulphuretted hydrogen, at the ordinary temperature, contains about three times its volume of the gas. 200 c.c. of a dilute solution of arsenic acid would then absorb, roughly speaking, 200 × 3 = 600 c.c. sulphuretted hydrogen gas. But 1000 c.c. sulphuretted hydrogen gas = 1·5199 grms.; consequently 600 c.c. gas = 0·912 grm. Now, 150 grms. As = 160 grms. S = 170 grms. H_2S for complete saturation. Hence the quantity of sulphuretted hydrogen absorbed by 600 c.c. solution—namely, 0·912 grm.—would suffice for precipitating 0·805 grm. arsenic. But since the gas must be present in large excess,* the amount of arsenic capable of being precipitated as the pentasulphide would be considerably less than 0·805 grm. I have found anything from 0·1 to 0·3 grm. to be a convenient quantity for a determination. The pentasulphide separates out in a thick skin, which adheres but slightly to the bottom and sides of the bottle. If the bottle, when cool, be inclined, the skin loosens itself, and one part can be made to overlap the other in a way which bears a striking resemblance to an omelette. The precipitate can be removed from the bottle without the slightest difficulty. When the sulphide, with the exception of a few particles, has been brought on the filter paper, a little water is put in the bottle, the stopper is inserted, and the whole violently shaken for a few moments. Thus the particles are freed from any adhering air, are broken up, and can then be removed from the bottle so completely that not a yellow speck can be detected on the glass. I used for test analyses the following solutions:—

1. N/10 solution of arsenic acid: This was prepared by oxidising 4·95 grms. pure dry arsenious acid with fuming nitric acid, evaporating, neutralising with ammonia, and diluting to a litre.

2. A standard solution of di-hydrogen potassium arseniate: This was prepared by dissolving about 25 grms. of the salt in water and diluting to two litres. By careful analysis 25 c.c. = 0·1292 grm. As, and 50 c.c. = 0·2585 grm. As.

The first quantitative experiments were made precisely as follows:—

A. The solution of arsenic acid was pipetted into the bottle, diluted to about 150 c.c., and rendered strongly acid with concentrated hydrochloric acid. The solution was treated with sulphuretted hydrogen gas until a decided opalescence made its appearance, when the bottle was closed, the stopper firmly tied down, and the whole placed in the boiling water-bath and here kept for one hour. At the end of the hour the bottle was removed from the bath, allowed to cool, and violently shaken so as to cause the pentasulphide to subside rapidly, leaving the supernatant liquid clear. Its contents were then filtered on a weighed filter paper, dried at 110° C. The precipitate was washed with water until a few drops of the filtrate gave no reaction for chlorine with nitrate of silver, and then, in regular order, six times with alcohol, four times with bisulphide of carbon, and again four times with alcohol. I used the pump in all cases. The drying was done at 110° C. and to constant weight. Two hours invariably proved sufficient.

Taken.	Calculated. Grm.	Found. Grm.
I. 20 c.c. N/10 H_3AsO_4	0·1550 As_2S_5 = 0·0750 As	0·1555 As_2S_5 = 0·0752 As
II. 30 c.c. N/10 H_3AsO_4	0·2325 As_2S_5 = 0·1125 As	0·2330 As_2S_5 = 0·1127 As
III. 50 c.c. N/10 H_3AsO_4	0·3875 As_2S_5 = 0·1875 As	0·3871 As_2S_5 = 0·1873 As
IV. 50 c.c. N/10 H_3AsO_4	0·3875 As_2S_5 = 0·1875 As	0·3879 As_2S_5 = 0·1877 As
V. 50 c.c. N/10 H_3AsO_4	0·3875 As_2S_5 = 0·1875 As	0·3875 As_2S_5 = 0·1875 As
VI. 50 c.c. N/10 H_3AsO_4	0·3875 As_2S_5 = 0·1875 As	0·3870 As_2S_5 = 0·1872 As

* See Fresenius, "Qualitative Analysis," 15te Auflage.

To see whether the trisulphide, when heated under pressure and in the presence of excess of sulphuretted hydrogen and a little air, could be made to take up sulphur and pass partially into the state of pentasulphide, I made the following experiment:—

50 c.c. N/10 arsenious acid were brought into the bottle, strongly acidified with hydrochloric acid, and saturated with sulphuretted hydrogen. Yellow trisulphide of arsenic was of course immediately precipitated. The bottle was closed and the whole heated in the boiling water-bath for one hour. I obtained, after filtering, washing, &c., 0·3095 grm. As_2S_3 = 0·1887 grm. As, whereas theory demands 0·1875 grm. The result is a trifle high, it is true, but the experiment certainly proves that no pentasulphide can be formed by heating together the trisulphide, sulphuretted hydrogen, and *small* quantities of air.

To avoid the use of alcohol and carbon bisulphide in washing the precipitate, I proceeded as follows, and, as will be seen, with complete success:—

B. The solution, after having been brought into the bottle and acidified with hydrochloric acid, was diluted with freshly boiled water until the bottle was nearly full, and then saturated with sulphuretted hydrogen. By so doing almost all the air was expelled from the bottle, and a subsequent separation of sulphur from the sulphuretted hydrogen by the action of any free oxygen rendered n to impossible.

The rest of the process was then conducted exactly as has been already described. The sulphide was washed with water until the filtrate was free from chlorine. I found it well, in order to promote the subsequent drying of the precipitate, to replace the water adhering to the same by running a small quantity of alcohol through the filter. This, however, is not necessary.

Taken.	Calculated. Grm.	Found. Grm.
I. 25 c.c. standard H_2KAsO_4	0·2670 As_2S_5 = 0·1292 As	0·2675 As_2S_5 = 0·1294 As
II. 25 c.c. standard H_2KAsO_4	0·2670 As_2S_5 = 0·1292 As	0·2671 As_2S_5 = 0·1292 As
III. 25 c.c. standard H_2KAsO_4	0·2670 As_2S_5 = 0·1292 As	0·2670 As_2S_5 = 0·1291 As
IV. 50 c.c. standard H_2KAsO_4	0·5340 As_2S_5 = 0·2584 As	0·5350 As_2S_5 = 0·2588 As
V. 50 c.c. standard H_2KAsO_4	0·5340 As_2S_5 = 0·2584 As	0·5331 As_2S_5 = 0·2580 As
VI. 50 c.c. standard H_2KAsO_4	0·5340 As_2S_5 = 0·2584 As	0·5333 As_2S_5 = 0·2581 As
VII. 50 c.c. standard H_2KAsO_4	0·5340 As_2S_5 = 0·2584 As	0·5335 As_2S_5 = 0·2582 As
VIII. 50 c.c. standard H_2KAsO_4	0·5340 As_2S_5 = 0·2584 As	0·5351 As_2S = 0·2588 As

50 c.c. of this standard solution were precipitated under pressure and washed according to the first method, *i.e.*, with water, until the filtrate was free from chlorine, then six times with alcohol, four times with bisulphide of carbon, and again three times with alcohol. I obtained 0·5326 grm. As_2S_5 = 0·2578 grm. As. The weight of the sulphide is somewhat below the required figure, but the corresponding amount of arsenic differs from the calculated quantity by only 0·0006 grm. It seemed well to analyse this standard solution by precipitating and weighing the arsenic as the trisulphide.

To do so, I reduced 50 c.c. by heating the same with sulphurous acid under pressure, boiled off the sulphurous acid remaining, and precipitated the arsenic with sulphuretted hydrogen. The precipitate was carefully filtered, washed, and dried according to Bunsen's directions. I obtained 0·4237 grm. As_2S_3 = 0·2583 grm. As. The amount required is 0·2584 grm. As.

To further test this method of determining arsenic, I had a friend make up a solution of arseniate of potassium,

* It seemed possible that, with the aid of the air remaining in the bottle the pentasulphide might be formed in accordance with the equation $As_2S_3 + 2H_2S + 2O = As_2S_5 + 2(H_2O)$.

such that every 50 c.c. contained between 0·2 and 0·3 grm. of arsenic. I made two analyses of this solution and obtained (1) 0·1336 grm. As, and (2) 0·1331 grm. As. The first precipitate was washed as Bunsen directs, the second according to my own method. The calculated result, as I was informed, was 0·1344 grm. As. The salt, however, is not absolutely pure as I have convinced myself by frequent and careful analysis. Allowing for the small amount of impurity, it will be seen that the agreement between the calculated quantity and the results found is entirely satisfactory.

I suggest, then, that when occasion arises for making an estimation of arsenic according to Bunsen's method, the modification here discussed be used. The process is a great improvement upon the Bunsen mode of procedure, for the following reasons:—1. It is remarkably rapid; 2. The quantity of sulphuretted hydrogen necessary for precipitation is reduced to a minimum; 3. No alcohol nor bisulphide of carbon is necessary for washing; and 4. The pentasulphide does not stick to the sides of the bottle, but separates out in such a state that every trace can be removed without even the aid of a feather.—*American Chemical Journal*, June, 1887.

ON THE

CHEMICAL COMPOSITION OF HOWLITE,

WITH A NOTE ON THE

GOOCH METHOD FOR THE DETERMINATION OF BORACIC ACID.

By S. L. PENFIELD and E. S. SPERRY.

This interesting mineral was first identified as a new species by Prof. Henry How,* of Windsor, Nova Scotia, who named it silicoborocalcite, assigning to it the composition—

$$2CaO.SiO_2 + 2(CaO_2.BO_3.HO) + BO_3.3HO,$$

written in the old system and in the form suggested by Prof. How. He described it as occurring in dense, chalk-like nodules, in the gypsum beds at Brookfield, near Windsor, N.S. In later papers† he mentions its occurring in four distinct localities near Windsor, the nodules being sometimes as large as a man's head and composed of minute scaly and silky crystals. The name howlite was substituted for silicoborocalcite by Prof. J. D. Dana, and used by him in the fifth edition of his "System of Mineralogy."

The specimen which we have examined was collected in the gypsum quarries at Windsor, N.S., by Mr. Charles G. Rupert, of Minneapolis, Minn., who generously presented it to the Mineralogical Department for investigation. It consisted of an egg-shaped nodule about 1½ inches in its greatest diameter, embedded in massive gypsum. The nodule was composed of intergrown microscopic needles, which under the microscope were resolved into flattened prismatic forms, having somewhat the shape of thin stilbite crystals, the largest 0·23 × 0·27 m.m., usually broken at the extremities, but occasionally terminated by two dome faces. In polarised light they showed parallel extinction, brilliant polarisation colours, red and yellow of the first order, according to the thickness of the crystal, the longer axis being the axis of least elasticity. In convergent light an obtuse bisectrix was very indistinctly seen, the plane of the optic axes being at right angles to the longer axis of the crystal. The crystallisation is therefore probably orthorhombic. Owing to the slight solubility of the mineral in water its specific gravity was taken in alcohol and found to be 2·59 referred to water. A sample was taken for analysis by breaking into the nodule and carefully freeing from adhering gypsum by hand-picking, but it was impossible to obtain the borate perfectly pure, a little SO_3 being found on analysis which undoubtedly resulted from adhering gypsum. The results of analysis of the air-dry powder are as follows:—

	I.	II.	Mean.
SiO_2	14·65	14·74	14·70
B_2O_3	42·68	42·70	42·69
CaO	28·22	28·19	28·20
Na_2O	0·55	0·47	0·51
K_2O	—	0·12	0·12
H_2O	12·01	11·94	11·97
SO_3	1·93	2·10	2·01
			100·20

Below the results are given after deducting 4·32 per cent of gypsum, corresponding to 2·01 per cent of SO_3, and calculating to 100·00 per cent, together with the analysis of How and the theoretical percentages derived from our ratio.

		Ratio.			How.	Calculated for $H_5Ca_2B_5SiO_{14}$
SiO_2	15·33	0·255		2·00	15·25	15·31
B_2O_3	44·52	0·636		5·00	[44·22]	44·65
CaO	27·94	0·498	0·507		28·65	28·56
Na_2O	0·53	0·008		3·99		
K_2O	0·13	0·001				
H_2O	11·55	0·641		5·04	11·84	11·48
	100·00				100·00	100·00

The ratio of $SiO_2 : B_2O_3 : CaO : H_2O = 2 : 5 : 4 : 5$ very closely, with a small part of the CaO replaced by Na_2O and K_2O. This is exactly the ratio obtained by Prof. How, but the analysis is of importance as proving the identity of this curious boro-silicate as a distinct species, the original analysis having been made on dense chalk-like varieties, and the most important constituent, B_2O_3, being determined by difference. The air-dry powder of the mineral lost water slowly at 100° C., but soon came to a constant weight at 150° C., losing 0·83 per cent, the mineral suffering no further loss by heating to 360°. The loss of 0·83 per cent corresponds closely to 0·90 per cent, the amount of water contained in the 4·32 per cent of gypsum which the analysed portion contained. Thus the loss of water at 150° C., as well as the SO_3 determination and the occurrence of the nodule in massive gypsum, suggest that there was a slight impurity of gypsum in the material which was analysed. The fact that the mineral does not part with its water at 360° C. indicates that the hydrogen is very firmly united in the molecule, probably as hydroxyl. The mineral is therefore a very acid silico-borate, and its formula may be written $H_5Ca_2B_5SiO_{14}$, differing essentially from the more common silico-borates of calcium, datolite, and danburite, in containing much less silica and more boracic acid, causing the mineral to be classified more naturally with the borates than with the silicates.

On igniting the mineral in a closed tube water is given off which reacts strongly for boracic acid with turmeric paper; the water in the above analysis was therefore obtained by ignition and absorption in a chloride of calcium tube. The boracic acid was determined by the admirable method suggested by Prof. F. A. Gooch.* The other constituents were determined by the usual methods.

Note on the Gooch Method for the Determination of Boracic Acid.

Before commencing the above analysis we carefully reviewed the method described by Prof. Gooch,† making a number of determinations of B_2O_3 in borax in order to become fully acquainted with the method. The distilling

* *Phil. Mag.*, IV., xxxv., p. 32.
† *Ibid.*, IV., xxxvii., 270, and xxxix., 278

* *Am. Chem. Journal*, ol. ix., p. 23, and Chemical News, vol. lv p. 7, Jan. 7, 1887.
† *Loc. cit.*

apparatus described by him proved very satisfactory. The boracic acid in our experiments was set free by nitric acid, distilled over with methyl alcohol, and evaporated with a weighed quantity of ignited calcium oxide. Without the use of very large platinum crucibles the evaporation of the boric ether with slaked lime is attended with some difficulty. The calcium borate together with the excess of lime form as a thick crystalline precipitate at the bottom of the crucible, and if the methyl alcohol boils during the evaporation some of the precipitate will be carried mechanically out of the crucible; then, too, the very strong ignition of the CaO necessary to bring it to a constant weight is not so readily accomplished if the crucibles are very large.

The following method was found to give very good satisfaction, and can be used by anyone having an ordinary sized platinum crucible, and preferably a platinum dish:—The lime, after being ignited to a constant weight and slaked, is transferred to a large platinum dish and warmed with water till it becomes of a milky consistency; it is not necessary to remove all the lime from the crucible, the latter being put away and used later on. Strong ammonia is poured into the receiving flask of the distilling apparatus described by Gooch, and, after conducting the distillation as directed, the contents of the receiver are poured into the platinum dish containing the slaked lime, water being freely used in rinsing out the receiver. The dish is then placed on a triangle over the water-bath, or otherwise gently heated till the volatile products, methyl alcohol and ammonia, are driven off, which by boiling might cause mechanical loss. When these are removed the contents of the dish can be evaporated to dryness. The dried calcium borate and the excess of lime are now transferred to the crucible in which the lime was weighed, this being easily accomplished by moistening the contents of the dish with water and shoving the bulk of the precipitate into the crucible with a spatula; by rinsing with a little water and by using a rubber on the end of a glass rod all but a very little of the borate and lime can be transferred to the crucible; that which sticks too firmly to the dish can be dissolved in one or two drops of dilute nitric acid which is brought in contact with all parts of the dish with the rubber; the solution is then transferred and rinsed into the crucible. The transfer and washing can readily be made by using not over 30 c.c. of water, which can be contained in an ordinary student's crucible. The evaporation from this point goes on very simply, the borate drying out nicely on the water-bath. By placing the platinum crucible in a large porcelain one and gradually raising the heat to strong igniton the borate may be further dried out without any danger of snapping. The residue is finally ignited over the blast-lamp till a constant weight is obtained.

In slaking the lime we have found it convenient not to add the water directly to the ignited lime, causing danger from excessive heating and mechanical loss, but to place the open crucible on a watch-glass containing water and covered with a bell-jar: in this way the lime soon slakes, and, in case of special hurry, hot water may be placed in the watch-glass from time to time so that the atmosphere under the bell-jar will be thoroughly saturated; in this way the lime will become so thoroughly slaked in one or two hours that there will be no danger of excessive heating on further addition of water.

The following results were obtained, using in all cases about 1 grm. of crystallised borax and 1 grm. of lime:— B_2O_3 in borax, 36·55, 36·42, 36·58, 36·64, calculated 36·64 per cent.—*American Journal of Science* (Third Series, vol. xxxiv., p. 220).

The Chemical Composition of a Brandy from Charente-Inferieure.—E. C. Morin.—Even in natural brandies the proportion of the higher alcohols is too large to be neglected. They contain furfurol and the bases met with in fusel oils.—*Comptes Rendus.*

REPORT OF THE COMMITTEE ON INDEXING CHEMICAL LITERATURE.*

The Committee on Indexing Chemical Literature respectfully presents to the Chemical Section its fifth annual report.

During the year Professor Charles E. Munroe completed and printed his Index to the Literature of Explosives, Part I., in an octavo pamphlet of forty-two pages. Part I. embraces the bibliography of the subject as found in the following complete sets of periodicals:—

Journal Royal United Service Institution, 1857—1885, 28 vols.

American Journal of Science, 1819—1886, 130 vols.

Philosophical Transactions (Royal Society), 1665—1882, 173 vols.

Revue d'artillerie, 1873—1884, 25 vols.

Proceedings U. S. Naval Institute, 1874—1885, 11 vols.

H. M. Inspector of Explosives (*Reports*), 1871—1885, 75 numbers; making in all no less than 442 volumes, which have been examined and indexed. In Part II., the author intends to continue with additional periodicals, and finally to give a subject and an author-index to the whole.

Dr. H. Carrington Bolton has published two brief bibliographical helps for chemists; the titles of which will be found in the list of Indexes at the close of this report.

Mr. A. Tuckerman of New York has completed an Index to the Literature of the Spectroscope, which will be printed by the Smithsonian Institution.

Though of local interest only, we mention in this connection a useful check-list of scientific journals published by a member of the Association. Mr. Clement W. Andrews has compiled a "List of the Scientific Periodicals in the Libraries of the various departments of the Massachusetts Institute of Technology [Boston], April, 1887." This list contains two hundred and forty-seven titles arranged alphabetically by the first word, with the exception of Official Reports. In connection with each title, indications are given of the particular departments of the Institute, nine in number, in which the periodical may be found.

Reports of progress have been received from the following gentlemen, on the indexes named:—

Professor F. W. Clarke, Specific Gravity Tables.
Professor W. H. Seaman, American Chemical Patents.
Mr. George F. Kunz, Gems and Precious Stones.
Mr. Clement W. Andrews, Milk Analysis.
Dr. F. E. Englehardt, Common Salt.
Dr. L. P. Kinnicutt, Meteorites.
Prof. Erastus G. Smith, Aluminium.
Mr. William Beer, Bibliography of Scientific Bibliographies.

The late lamented Professor Wm. Ripley Nichols left his Index to the Literature of Carbon Monoxide unpublished, yet so well advanced as to permit its extension and completion; this has been undertaken by Mr. Augustus H. Gill, of the Massachusetts Institute of Technology.

Offers of voluntary coöperation have been received from two chemists: Dr. Frank W. Traphagen, of Staunton, Va., has undertaken to compile an Index to the Literature of Bromine, and Mr. A. P. Bjerregaard, of the Astor Library, New York, has begun work on an Index to the Literature of Chromium, both subjects having been suggested by the Committee.

As stated in an earlier report the Committee deems it advisable to note important bibliographical undertakings which come under its observation. Attention is called to the extensive Index to Meteorological Literature now preparing by Mr. C. J. Sawyer, of the Signal Office, War

* *From the Proceedings of the American Association for the Advancement of Science*, Vol. xxxvi.

Department. It is a classified index containing about 50,000 titles on meteorology and terrestrial magnetism, including separate works, memoirs, and published observations. It will be accompanied by a full author-index. The date of publication of the manuscript will depend on congressional action.

When committees for the preparation of indexes and bibliographies of special topics are appointed by both the American and the British Associations for the Advancement of Science, it is eminently desirable that they should coöperate as far as practicable. A beginning has already been made in the direction of an International Committee by the appointment of one of the members of our Committee (Prof. Leeds) to serve on the Committee of the British Association for indexing the literature of Solution. The circulars issued for the members contain a scheme of classification and a list of the periodicals, thirty-one in number, which it is proposed to index. The project also calls for original work. Those desiring further information should address W. W. S. Nicol, the Secretary, at the Mason Science College, Birmingham.

Members of the Chemical Section who attended the Buffalo meeting will remember that one of the Committee discussed in a brief article the desirability of greater uniformity in the abbreviations of Journal titles and suggested the formation of a Standard List for chemistry. The proposition was favourably received by the Section, and the Committee, reinforced by Prof. C. K. Wead and Mr. S. H. Scudder, has devoted much thought and time to the preparation of such a list. During the progress of the work the Committe was favoured with suggestions from Mr. Clement W. Andrews, of the Massachusetts Institute of Technology, and from Prof. William Frear, of the Pennsylvania State College. Both of these gentlemen kindly drew up lists of abbreviations for the use of the Committee. The Committee does not think it necessary in this place to detail the many difficulties encountered, but present to the Section a succinct statement of the principles by which it was governed in preparing the Standard List.

Principles for Abbreviation of Titles.

1. Follow established usages when possible.
2. While seeking brevity avoid obscurity.
3. Brevity and perspicuity are not to be sacrificed to consistency.
4. Follow the rules 1, 3, and 4 as laid down by Dr. J. S. Billings, viz.:—"(1) Follow the exact order of words of the title. (3) Follow the orthographical usages of each language; this rule disposes of capitalisation. (4) Attain uniformity as far as possible."
5. If possible, indicate languages of titles by use of articles and conjunctions, or by spelling.
6. When necessary to differentiate add names of editors or places of publication.
7. Abbreviations should be intelligible without a key.
8. Optional words are placed in parentheses.
9. Obscure journals require fuller abbreviations than those frequently cited.

These principles were adopted after personal conference and correspondence, by a majority of the Committee; Dr. Alexis A. Julien, however, though welcoming this provisional list, expressed the wish for briefer abbreviations, and at his request we insert a summary of his views.

Dr. Julien thinks further contraction of the abbreviations desirable, chiefly by omission of vowels, even if established usages are sometimes abandoned. He thinks that consonants indicating roots philologically are in many cases sufficient; such as *Grn.* for *Giorn.*, &c.; he favours the following *Ch.* for *Chem.* and for *Chim.*, since the articles or conjunctions indicate the languages. Where the title of a journal is not readily confounded with that of any other he favours utmost contraction. He thinks the Standard List of Abbreviations will be more useful and more widely adopted if the abbreviations are shortened to a greater degree than in the subjoined list.

Mr. S. H. Scudder also dissents from the views of the majority of the Committee, approaching those of Dr. Julien but not going so far. He favours omission of all articles, prepositions, and conjunctions, and regards the Provisional List of Abbreviations as burdensome and as supposing an unreasonable lack of acquaintance with names of Journals. He also somewhat prefers adding place of publication instead of name of editor when necessary to differentiate, and would always end abbreviations (unless elliptical) with a consonant. He suggested several shorter contractions than those of the manuscript submitted to him, which the Chairman has ventured to incorporate in the Provisional List.

The majority of the Committee took a strongly conservative view of the matter. They felt that the abbreviations should in every case suggest to one moderately familiar with chemical periodical literature the name of the Journal indicated; they therefore avoided the use of symbols, or single letter abbreviations except in the sole instance of "J" for journal—already conventional. At the same time the abbreviations in the following list will be found briefer and more easily recognised than those in the Catalogue of Scientific Papers published by the Royal Society, or in the Index-Catalogue of the Library of the Surgeon General's Office. Yet they believe they are full enough to be used without obscurity, in such Catalogues as these, covering almost the whole range of scientific journals.

The members of the Committee do not regard this report as the proper place to explain fully the reasons which have led to the adoption of each of the two hundred abbreviations submitted herewith; nor do they feel called upon to defend their choice. But they do earnestly desire that, before their critics undertake further condensation in certain cases that seem to be needlessly extended, they shall examine the titles of a compendious bibliography of scientific periodicals. By so doing they will perceive the necessity of differentiation, and that provision has been made to avoid confounding journals having closely similar titles.

The Committee also realises that it may often be desirable to shorten a given abbreviation for special reasons, as for example in printing tables, or where a large number of citations are made from a single journal. This conversion of abbreviations into "symbols" must be left to the judgment and necessities of individuals.

In presenting to the Section the draft of a list of abbreviations for their scrutiny and approval or disapproval, the Committee desires it to be distinctly understood that the list is a provisional one and subject to such amendments as the Section may direct. The Committee respectfully suggests that the Provisional List annexed to this Report be printed for use of members of the Chemical Section, and that the Section take no action upon the list as a whole until the meeting of 1888. In the interim the Provisional List can be subjected to the test of usage, and improvements or amendments which suggest themselves on trial can be recorded. All suggestions will be welcomed by the Chairman of the Committee, to whom they should be addressed.

Several years having elapsed since the publication of a list of the indexes in print, the Committee deems it advisable to re-publish the list brought up to date, together with memoranda indicating where the indexes can be obtained. Unfortunately some are out of print.

The Committee again thanks the Association and the Smithsonian Institution for services which save the Committee from incurring the expenses of printing and mailing reports.

The Committee begs leave to refer chemists receiving this report to their oft-announced appeals for voluntary co-operation in the work which it has in charge. Sample copies of Indexes and other information can be had by

addressing the chairman, care of the Smithsonian Institution.

H. Carrington Bolton, *Chairman.*
F. W. Clarke, (absent in Europe).
Albert R. Leeds.
Alexis A. Julien.
John W. Langley.
Samuel H. Scudder.
C. K. Wead.

(To be continued).

NOTICES OF BOOKS.

The Chemistry of the Sun. By J. Norman Lockyer, F.R.S. London and New York: Macmillan and Co.

The purport of this work may be at once gathered from the two mottoes which the author has placed at the head of his preface. From Dalton, one of the most sober and least imaginative of modern chemists, he quotes the admission that "We do not know that any one of the bodies denominated elementary is absolutely indecomposable." From Graham's "Researches" (p. 299) he cites the passage—"It is conceivable that the various kinds of matters, now recognised in different elementary substances, may possess one and the same ultimate or atomic molecule existing in different conditions of movement. The essential unity of matter is an hypothesis in harmony with the equal action of all bodies."

Thus, Mr. Lockyer does not seek to give us here a summary of celestial spectroscopy. He does not even speculate on the origin and nature of the sun; but he asks what light does a spectroscopic study of the sun and of the fixed stars throw upon the fundamental problem of chemistry,—the real nature of our so-called elements?

Hence any inquiry into the accuracy or the completeness of the history of spectroscopy, which occupies the first chapters of this work, is really beside the main question. Are our elements absolutely distinct, having either existed from all eternity or having been created such as we now find them; or are they compounds of some simpler bodies, perhaps different forms of one primordial matter? Are they capable of decomposition at extreme temperatures and of again re-uniting to their former condition as they cool? For a reply Mr. Lockyer refers us to the phenomena detected in the sun and the fixed stars by spectroscopic investigation. He appeals, in the first place, to the law of continuity. At every increase of temperature—which is *the* dissociating power—bodies within the temperatures at our command are separated from each other. To chemists such separations are so familiar that instances would be needless. We then ask, with the author, Is a temperature higher than any yet applied to act in the same way as each higher temperature which has yet been applied has done? Or is there to be some unexplained break in the uniformity of Nature's processes? There are minds to whom this appeal, in the absence of distinct evidence to the contrary, will seem conclusive. There are others, including all opponents of Evolution, who refuse to recognise the law of continuity wherever it has not been already established. To such minds the author has, therefore, to address himself. Have we therefore any evidence that with increasing temperature we have increasing dissociation, or, in other words, increasing simplification of the matter exposed to such temperature? Surely we have: quite independent of Mr. Norman Lockyer and his hypothesis we recognise in the hottest stars, such as Sirius and Vega, a spectrum remarkable for its simplicity. "The lines in their spectra are matched by lines which we see in the spectra of hydrogen, magnesium, and perhaps of sodium," the first greatly predominating, and the two latter substances being but feebly indicated.

We next come to a second class of stars, to which belongs our sun. Here we find evidence of a reduced temperature, whilst at the same time the indications of hydrogen are distinctly reduced and the complexity of the entire spectrum is wonderfully increased. It is here important to note that "the complexity" which we meet with in passing from the first class to the second is brought about by the addition of the lines produced by chemical substances of moderate atomic weight.

We now come to a third class. Here the hydrogen has altogether disappeared; the complexity of the spectrum has still further increased by the addition of lines mainly due to bodies of higher atomic weights.

If we again revert to these three classes of stars we find them in succession intensely hot, moderately hot, and less hot. As they become cooler the complexity of their spectra increases. The hottest class contain bodies only of very low atomic weight. In the intermediate we find an increased number of bodies, including those of medium atomic weight; whilst in the third cooler group not only is there evidence of a further increase in the number of bodies, but some of the higher atomic weights now make their appearance.

How, then, are we to interpret these facts? Are we to assume that the various stars differ quite accidentally in their chemical composition? Or shall we not rather conclude, as more agreeable with the facts, that we have here, with the progressive reduction of temperature, a progressive *association* of matter—existing previously in unknown states—so as to form our recognised elements?

Mr. Norman Lockyer has approached the question as a physicist; but he does not fail to produce the evidence of chemists in support of the possible dissociation of these elements. Dumas, Berthelot, Brodie, Sterry Hunt agree with Dalton and Graham that such elements can claim nothing higher than a provisional character, marking out not any definite ultimate stage in Nature, but merely the present limit of man's power,—a limit, we may venture to add, which even now shows signs of yielding. If temperature has no absolute maximum it may he hard to surmise to what lengths dissociation may be carried.

It is commonly asserted that we have never succeeded in our laboratories in decomposing an element; but what if the different spectra which we obtain when a substance is ignited by a Bunsen burner, and, on the other hand, by an arc light, indicate that in the latter case a dissociation—on the small scale—of the metallic particle is really taking place, and that we are working with matter similar to that which may be found in the laboratory of the Sun?

We have not space to follow Mr. Lockyer through the interesting comparison between the results which must flow from the hypothesis of dissociation and phenomena actually observed. Suffice it to say that they warrant us, in our opinion, in granting to this hypothesis at least a provisional assent, taking it as a guide in working and submitting it constantly to the test of renewed and extended operation. That it will be modified, corrected, extended, we fully believe; but we do not suppose that it will ever be rejected as a mere speculation.

We may here call attention to the researches of Prof. Grüenwald, which have recently appeared in the Chemical News, and which decidedly support Mr. Lockyer's hypothesis. He concludes that even hydrogen is a compound body, formed of helium, coronium, and a still rarer body.

Elementary Chemistry. By M. M. Pattison Muir, M.A., Fellow and Prælector in Chemistry of Gonville and Caius College, and Charles Slater, M.A., M.B., formerly Scholar of St. John's College, Cambridge. Cambridge: The University Press.

This work bears a well-marked relation to its companion volume, Pattison Muir and Carnegie's "Practical Chemistry." Some of the earlier chapters especially, in both, might—if very briefly summarised—be pronounced identical. In each we find discussed, *seriatim*, chemical

change, elements and not elements, mixtures and compounds, the conservation of matter, &c. But on examination it will be seen that in the two works these subjects are approached respectively from different sides, the one being complementary to the other.

In the very outset of "Elementary Chemistry" we find some explanatory remarks of great value. Say the authors—"The aim of Science is to see things as they are. But to see things as they are it is necessary to study the relations of things, because in Nature nothing is wholly cut off from other things, but everything is either a cause or a consequence of many other things, and is related in manifold ways even to things which may seem to be wholly unconnected with it." This is, beyond question, sound teaching.

The object of the book, we are further told, is "to place before the student an outline of the methods by which chemistry proceeds; to teach him some of the general laws of the science, and to show him that the laws are gained by studying natural occurrences."

No inconsiderable part of the work is devoted to an exposition of the periodic law and to the study of the elements as arranged in accordance with that law. This is a very valuable feature, the more so as in many elementary chemical treatises it is scarcely brought into sufficient prominence. It may, however, be doubted whether Mr. Newlands receives the full share of credit justly due to him as the proposer of the periodic classification.

The authors' remarks on structural formulæ will commend themselves to the judicious chemist. They say—"Structural formulæ are the most developed forms of chemical language · they express much, but not all: of them it may emphatically be said 'They are wise men's counters, but the money of fools.'"

We find in this book no reference to the thermochemical researches of Berthelot, Thomsen, and others, and to the light which they throw upon chemical interaction.

In the concluding chapter we find an utterance which we cannot unhesitatingly accept, *i.e.*, "Chemistry is the daughter of alchemy." We should rather say that alchemy was a temporary aberration which chemistry underwent at an early stage of its growth. The final sentence is significant:—"Chemists have found the elements, and beneath the elements they have found the atoms, and beneath the atoms they sometimes think they perceive the atoms of the one element of which all the known elements and compounds, it may be, are developed forms."

Every student of Science, not merely those who purpose becoming chemical specialists, will do well to add this volume to his library, and to read it heedfully.

Practical Chemistry: a Course of Laboratory Work. By M. M. Pattison Muir, M.A., Fellow and Prælector in Chemistry of Gonville and Caius College, and Douglas Carnegie, B.A., Demonstrator in Chemistry, and formerly Scholar of Gonville and Caius College, Cambridge. Cambridge: The University Press.

In this book the object of the authors is to teach the leading principles of chemistry by a series of very simple experiments, from the results of which the student can draw certain conclusions. This plan is in many respects preferable to the routine system of taking up the elements one by one and describing their respective properties.

In the first part we find explanations of the differences between chemical and physical changes, between elements and non-elements, between mixtures and compounds, the pupil seeing, not hearing, the answers. The classification of elements, which is given in a similar manner, extends only to the halogens, the groups magnesium zinc cadmium, nitrogen phosphorus arsenic antimony bismuth, and chromium manganese iron. The worn-out division of the elements into metals and non-metals—or metalloids as some writers still persist in calling them—is not brough forward.

The second part deals with the laws of chemical com bination, equivalents, combining weights, molecular an atomic weights, &c.

In the third part we find, among other matter, an explanation of the methods of determining the constitutions of compounds.

There are Appendices on experiments suggested in Part I., Tables for qualitative analysis, and useful numerical data. There is an excellent Index, and—a sti more satisfactory feature—there is no list of questions given at any examination.

An Almanack for the Year of Our Lord 1888. By Joseph Whitaker, F.S.A. London: 12, Warwick Lane.

This well-known and valued annual goes on its way, presenting year by year more useful matter. In examining it we turn naturally first to the section "Societies and Institutions," which comprises a medley of bodies, scientific, religious, benevolent, and political. We are glad to note that certain societies of the "anti" class—*i.e.*, those organised to abolish and suppress something existing—are not advertised. One organisation, which might be very useful if it were less characterised by "masterly inactivity," is omitted,—the "Society for the Advancement of Medicine by Research," 19 Savile Row, W.

We do not find any mention of the Royal Society of Edinburgh, the Royal Irish Academy, nor of the leading provincial scientific bodies.

In examining other portions of this work we come upon certain facts which to us at least appear highly unsatisfactory. We note that the funds at the disposal of the Natural History Department of the British Museum are only £43,000 yearly. If we turn to the particulars given concerning the institutions of higher education we see that Science is very far from occupying a fair position In almost every case literature and especially classics occupy the leading position. In many public schools there appears to be no professor or master for any branch of physical or natural science. In one school we see that there are *fourteen* "assistant classical masters," whilst for Science—apparently the entire range from astronomy to biology—there is but one. The friends of Science who wish to see this country at least equal any Continental nation in research and discovery have still an arduous task before them.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

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Comptes Rendus Hebdomadaires des Séances de l'Académi des Sciences. Vol. cv., No. 21, November 21, 1887.

On the Crystalline Form of Cinchonamine.— C. Friedel.—The crystals deposited on cooling an alcoholic solution appear in hexagonal prisms ending in a rhombohedran.

On a Simple Relation among the Wave-lengths of Spectra.—A. E. Nordenskiöld.—Some years ago the author discovered a simple mathematical relation among the wave-lengths of the spectra of the different elements that is, in these spectra the differences among the logarithms of the wave-lengths for each element are often simple multiples of the same number. The author was unable, at the time, to conclude these researches, especially as the extreme abundance of rays, which distinguishes the spectra of most of the elements, render

them unfit for solving the question. It appeared that the spectra of the rare earths, on account of their sufficient number of rays for the most part at convenient distances, were peculiarly suited for examining if there existed a mathematical relation analogous to that which the author believes he has discovered among the rays of the spark spectra of different elements, and if this ratio depended on a natural law, or merely on an apparent coincidence between the figures calculated and those observed. The orty absorption rays which MM. Krüss and Nilson represent in their memoir on the absorption-spectra of the rare earths may be divided into two groups, each presenting the fact that the differences of the logarithms of the wave-lengths are simple multiples of one and the same number, or, what amounts to the same thing, the wave lengths of the different absorption rays may be expressed by the formula $\lambda = a^n k$. Here a and k are for each group characteristic constants, and n is a whole number.

On a Blue Derivative of Morphine.—P. Chastaing and E. Barillot.—In a former memoir the authors have shown the formation of derivatives of morphine, produced by the action of oxalic, malonic, and succinic acids upon morphine in presence of sulphuric acid. From these derivatives there is formed, by means of limited oxidation, a blue product, which the authors name morphine blue. Analogous compounds are formed if codeine is substituted for morphine. To obtain morphine blue one of the above derivatives is dissolved in caustic potash and the mixture is exposed to the air or is treated with a current of air. In a couple of days, when the liquid no longer absorbs carbonic acid, there is added a slight excess of hydrochloric acid, when blue flocks are precipitated, which are collected, washed, dried in a vacuum, and when dry exhausted with boiling chloroform. Blue crystals are formed on its spontaneous evaporation. The formula of morphine blue, dried at 120° to 125°, is $C_{26}H_{22}N_2O_4$. The formation of this colour is an extremely delicate reaction for detecting races of morphine, even in presence of other organic matter.

On a Butylenic Base, and on the Characters of a Class of Diamines.—Albert Colson.—The base in question is formed as follows:—10 grms. isobutylenic bibromide (boiling at 147° to 149°), dissolved in 40 c.c. of aniline, are boiled for ten minutes; the excess of aniline is expelled by distillation in a vacuum; the aniline hydrobromide is removed by washing in cold water, when there remains a viscid matter, insoluble in water, consisting of the butylenic base contaminated with aniline. A secondary aromatic diamine with an ethylenic grouping is distinguished from the primary amines (such as aniline, oluidine, &c.) by its not acting upon phthaleine, whilst ts basic character is shown by methyl-orange. As the molecular weight augments the basic character diminishes.

On the Speed of the Formation of the Ethers.—N. Menschutkine.—The author's conclusions are:—Among all the alcohols the methylic alcohol has the highest constant of speed. The constants of speed differ according to the isomerism of the alcohols; other things being equal the highest constants belong to the primary alcohols (48 to 16), then to the secondary alcohols (14 to 6); those of the tertiaries are very small. In each of these classes the constants of speed vary according to the isomerism of their hydrocarbon radicles. In the series of homologous alcohols of analogous structure the increase of molecular weight reduces the constant of speed. The homologic decrease of the constant is greatest in the series of normal primary alcohols. The series of non-saturated alcohols have lower constants than saturated alcohols containing the same proportion of atoms of carbon.

The Production of Peptone by a Chemical Reaction.—A. Clermont.—The author has succeeded in obtaining the purely alimentary peptonea and syntonine by a simple chemical reaction.

Bulletin de la Société Chimique de Paris.
Vol. xlviii., No. 1, July 5, 1887.

Action of Triethylamine upon α-Bromo-butyric Acid.—E. Duvillier.—Whether the triethylamine is dry or moist the principal product of its reaction upon α-bromo-butyric acid is α-oxybutyric acid, no betaine being formed If the triethylamine is dry there is formed a trace of tetra-ethyl-ammonium hydrate, and doubtless also a trace of crotonic acid.

On the Bacterian and Physiological Alkaloids Ptomaines and Leucomaines.—Armand Gautier.—The greater portion of the matter contained in this memoir has already been noticed under a separate work of the author's. He remarks, however, that the ptomaines and the leucomaines are not the sole poisonous substances produced in the living organism. Along with them there exist non-alkaline extractive substances, still more formidable, probably forming the principal and the most active part of the poison of serpents.

Function and Derivatives of Cyan-aceto-phenone.—Alb. Haller.—Cyan-aceto-phenone is met with in the form of white needles, soluble in boiling water, alcohol, and ether; sparingly soluble in petroleum ether and cold water. It melts at 85·5°. The author examines the behaviour of this substance with hydrochloric acid in an alcoholic solution.

On Cyan-acetic Ether.—Alb. Haller.—The author examines whether cyanacetic ether, which contains a methylene group, comprised between CN and $CO_2C_2H_3$, is not capable of having its hydrogen substituted by a metal. He has obtained a sodium compound, from which other metallic compounds, such as those of silver, copper, and zinc, have been obtained by double decomposition.

The Hydrates of Barium Chloride.—H. Lescœur.—The author has obtained two definite hydrates, the ordinary hydrate and the monohydrate, the latter of which is not mentioned in the text-books.

The Derivatives of Erythrene.—Edouard Grimaux and C. Cloëz.—The authors are engaged with the study of erythrene tetrabromide, isobromide, and dibromide, and their derivatives.

Action of Sulphuric Acid upon the Higher Chloro-Benzines.—M. Istrati.—In examining the sulphonic derivatives of tetra-chloro- and penta-chloro- benzine, the author obtains a compound which he names *franceine*, which will be the head of a series of colouring-matters now under examination. This colouring-matter possesses tinctorial powers much more intense than an alcoholic solution of eosine. A solution at 1-500th agrees in colouring power with a one per cent solution of eosine. If applied to the colouration of histological preparations it seems to combine the elective powers of eosine and hæmatoxyline.

On Certain Nitro-derivatives of the Chlorised Ethylbenzenes.—M. Istrati.—In operating upon the ethylated derivative of para-dichloro-benzene the author has obtained two compounds, which he has not named. The second seems to be a mixture of two isomers.

The Hydration of Diallyl.—A. Béhal.—This memoir does not admit of useful abstraction.

Action of Alumina and Kaolin upon Calcium Chloride.—A. Gorgen.—Calcium chloride, if mixed with alumina, kaolin, or common clay, and melted at cherry-redness in presence of moist air, is gradually transformed into certain crystalline bodies soluble in dilute acids. For the present the author merely points out the existence o these bodies without entering into their composition.

Derivatives of Erythrite and of Compressed Gas (Coal-Gas).—Albert Colson.—M. Henninger has already connected erythrene with the crotonylene extracted by Caventon from compressed gas. The author has examined the erythrene hexa-bromides, nitro-bromo-azotine, and the butylenes of compressed gas. The portion of this passing

over at 148° is isobutylene bromide; the second portion consists of diethylidene bromides, and the third agrees in its boiling-point with ethyl-vinyl bromide, found by M. Lebel in the oils of Boghead mineral.

On Carotine.—M. Arnaud.—The author speaks of the properties of carotine, of the precautions to be taken in its extraction, and of its occurrence in various plants, the nettle being the richest in this colouring-matter.

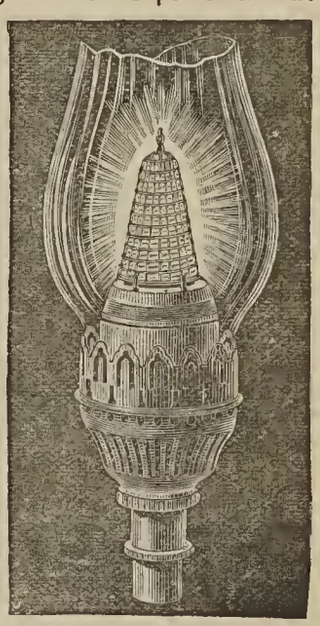
On Novel Chloro-derivatives of Anisol. — L. Hugounenq.—The author has obtained a number of new compounds, which are still under examination.

MISCELLANEOUS.

Royal Institution of Great Britain.—The following Lectures on "Astronomy," adapted to a juvenile auditory, will be given by Sir Robert Stawell Ball, LL.D., F.R.S., Royal Astronomer of Ireland, at 3 p.m.:—Tuesday, December 27, The Sun; Thursday, December 29, The Moon; Saturday, December 31, The Small Planets.

Diaries for 1888.—We have received a few specimens of Letts's Diaries, published by Cassell and Co., and can recommend them as being quite up to the usual high standard which we are accustomed to look for in works published by this firm.

The Clamond Incandescent Gas-Light. — This light is one of the most formidable rivals to the electric incandescence-burner which has yet appeared in the field. Its construction may be seen from the accompanying cut. Not a few eminent authorities—some of whom, however, seem to be or to have been officially interested in gas—report most favourably upon its efficacy. It is pronouced to be barely distinguishable from the electric light, requiring no motive power and no outlay beyond



the cost of the burners, which can be adjusted to any gas-fittings. The light is said to be steady, bright, and white, and the combustion practically perfect, no damage being occasioned to ceilings, &c., by the deposition of carbon. We find, however, no reference to the generation of sulphurous acid, which, after all, is the greatest objection to gas. The only two burners mentioned in the circulars of the Æolus Water-spray Ventilating Company, the sole agents for this invention, are much too large for use in the generality of private houses, but we presume burners of 8, 10, &c., candle-power are also made.

Preparation of Allyl Iodide; Formation of Allylic Alcohol.—A. Béhal.—The author, after criticising the processes at present in use, proposes a modification of the method of MM. Berthelot and de Luca. He introduces into a tubulated retort holding about 4 litres 2000 grms. glycerin, 60 grms. iodine, and 200 grms. red phosphorus. After stirring well he adapts a refrigerator to the retort and fits a bromine apparatus to the tubulure. He dissolves 440 grms. of iodine in the allyl iodide of a former operation, or dissolves it gradually in the first portions of allyl iodide which pass over, a process which is attended with liberation of heat. The retort is heated over an open fire until the reaction begins and the mass froths strongly. The fire is then regulated so as to maintain a gentle boil and the solution of iodine is let fall in by drops. The allyl iodide passes over slightly coloured by iodine, but when all the iodine has been added it may be obtained colourless by re-distilling. When the operation is completed a very gentle fire is kept up under the retort, and there passes over an aqueous liquid and a certain quantity of allyl iodide. This aqueous liquid contains a large proportion of allylic alcohol.—*Bull. de la Soc. Chimique*, Vol. xlvii., No. 11.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Analyses of Paints.—I wish to know where I will find information as to the analyses of mixed paints.—R.S.

Etching Ink.—Can any reader inform me whether he knows of a method of making a "printing ink" (etching) which is not affected by a weak solution of nitric acid, say one in twenty?—J.H.B.

India-Rubber Cuttings.—Will any reader kindly give me some information as to dissolving or otherwise treating india-rubber cuttings so that they may be readily cast into moulds?—Frank Jordan.

CORTIN'S New Patent NON-ROTATIVE ACID VALVE. For use with Acids or other Corrosive Fluids, Exhaust Gases, &c. This Valve has been universally adopted by the leading Chemical Firms throughout Great Britain, and is pronounced by the most competent authorities to be the only perfect and practical Valve yet invented. Many hundreds now in use. One Valve will last longer than the combined lives of a large number of Cocks or other ordinary means. Entire satisfaction guaranteed. Highest testimonials. Price lists, illustrations, or sample on application — J. CORTIN, Chemical Plant Manufacturer, Newcastle-on-Tyne.

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THE CHEMICAL NEWS.

Vol. LVI No. 1466.

NOTE ON A

SPECIMEN OF GOLD QUARTZ FROM THE TRANSVAAL.

By PHILIP HOLLAND, F.C.S., Public Analyst for Southport.

A short time since I received from a friend a small piece of auriferous quartz. It came from the famous Sheba Reef in the Republic of the Transvaal, and was one of several fragments collected and brought home by a gentleman who had visited the spot in 1886.

I may just mention that the Sheba Hill is distant some 15 miles or so from Barberton, a town that takes its name from two brothers Barber, who found gold in the immediate neighbourhood about two years ago. Prior to the discovery of gold the site of Barberton was probably ittle more than a topographical expression. In the short space of two years, however, quite a large town has sprung into existence, and has become the important centre and head-quarters of a large mixed mining population, numbering, it is said, with those who cater for it, over 4000 people.

Short accounts of the search for gold, and the way in which the mining is conducted, have from time to time appeared in the daily press, but perhaps the most important additions to the general literature of the subject are to be found in a letter from a Cape correspondent to *The Times* of September 23rd, 1886, and in the chatty article contributed by Mr. G. J. Nathan to the current number of *Longman's Magazine*.

My specimen of quartz came, I understand, from the Sheba Hill, which, according to *The Times* letter, is but one of several extensive properties owned by "The Sheba Reef Gold Mining Company." It weighed 18 grms., and was in the form of a splinter or chip, broader at one end than the other. At the broad end was a fissure, about a millimetre wide, stained with ferric oxide, whilst near by and along the line of the fissure gold was distinctly visible without a lens, but could not be seen on any other part of the specimen.

The rock is of a greenish grey colour, and would be described as dark-coloured massive quartz. It differs in general appearance from other Transvaal specimens sent me from Natal, but not yet examined,—one being a lighter quartz than Sheba Hill, with, however, a band of a darker variety more akin to the above running along one face of it; and another a conglomerate consisting of large rounded quartz pebbles, imbedded in a hard red matrix, and said to be rich.

To return, however, to the Sheba Hill sample. I first removed the portion containing the visible gold, setting it aside for special tests; and before powdering the rest for analysis, I carefully overhauled several of the fragments with a lens, which revealed very minute specks of gold, or what then appeared to be gold, on some of them. That the bright yellow particles seen with the lens must not all be assumed to be gold was at once evident on heating some of the powdered rock in an open tube, when SO_2 came off. The rock then contains pyrites probably, and much gold certainly, for on testing a portion of the roasted powder by Skey's method a very distinct reaction was got from a quantity not exceeding 0·17 grm., the whole operation being complete in half an hour. There is a sweet simplicity about this plan of finding small amounts of gold which should, I think, recommend it to prospectors, most of whom will probably have sufficient skill to apply it intelligently.

The examination, then, of the quartz so ar shows that what presumably is pyrites is associated with the gold, and the question naturally suggests itself—How mnch of the gold is locked up in the pyrites, and therefore not extractable by mercury? This question is one the small amount of material I had does not enable me to answer, but I may state that I am informed in a letter from Natal that the waste from the amalgamators of some companies is said to contain as much as 8 ounces of gold per ton My correspondent, who considers the statement should be received with caution, remarks at the same time that the report has a solid kernel of fact, based on dry assays of the waste made by the chemist to the Transvaal Government. Auriferous mercury is probably present in this waste; should it, however, be as gold-laden as report makes out, there would appear to be "a potentiality of becoming rich beyond the dreams of avarice" for the man who is lucky enough to hit on a cheap and effective plan of extracting the waste on the spot. I am not aware if anything is at present being done in this direction. It would seem the heavy cost of transport bars the way to the importation of chemicals. Some of the original material is being treated in England I hear,—that is to say, the pyritous gold quartz,—but I am not told from what part of the Transvaal it was taken.

When analysing the Sheba Hill specimen I should remark that my object has not been so much to find the amount of gold in it as to learn something of the character of the rock itself,—that is to say, to learn with what rock-forming minerals the gold is associated. To this end sections have been cut by Mr. Norman, of the City Road, which my friend Mr. F. Rutley has kindly examined. He says of them—"The quartz appears to be an ordinary example of vein quartz, the constituent crystals exhibiting irregular boundaries, the structure being what Rosenbusch terms 'allotriomorphous.' The patches in the section which I take to be felspar are not easy to recognise as such. There is also some matter present apparently of a micaceous character." (Small specks of mica were to be seen on the specimens before it was broken up.—P. H.) "This may be muscovite or paragonite. The opaque mineral appears to be partly in irregularly-shaped grains and cubes, partly in forms which give a six-sided outline such as a pentagonal dodecahedron might yield. I think these cubes are pyrites, for I have compared them with gold, first, in a Californian specimen with a ground surface, on which, as I expected, the scoring of the slitting disc was distinctly visible; and again with a small pellet of Californian gold, which I flattened and ground with emery flour. In the latter case the scoring of the emery was very marked. The colour of the crystals in the Sheba quartz is also different from that of undoubted gold. They show, moreover, *no* scoring on their surfaces. I have little doubt that these crystals are pyrites. In your section there are a very few extremely minute opaque crystals, apparently in some cases octahedra, which by surface illumination reflect the light brilliantly on rotating the stage of the microscope. These I think may be gold, for although such brilliant reflection is not usually given by the faces of gold crystals of moderate dimensions, yet it may be seen in certain minute crystallisations, as in some gold specimens from Transylvania and in gold which has been crystallised by fusion with bismuth, the latter metal being subsequently dissolved out with nitric acid. There are numerous fluid lacunæ in the quartz."

As regards the chemical analysis it may be sufficient to say that the bases Al_2O_3, Fe_2O_3, and MgO were brought into solution by treating the very finely powdered sample with re-distilled solution of HF, the usual plan of operations when using this acid being followed. I should observe, parenthetically, that re-distilled solution of HF is not the article sold as such, but acid specially prepared in an apparatus with a condensing arrangement of platinum. Some fluoric acid, by accident or design, contains much H_2SO_4 and SO_2, and is not well suited for the analyses of silicates. I weighed out 2 grms. of the

quartz, making up the final solution, from which all SiF_4 and excess of vitriol had been removed, to the volume of 500 c.c. In this the estimation of the bases above mentioned was duplicated. I may state that a little carbon was observed in this quartz, as was the case in the Nill's Hill quartzite of which I gave an account some months ago.*

Potash being detected spectroscopically, this base and soda were determined on 1 grm. of material by Dr. L. Smith's plan. Lithia was absent. The SiO_2 and combined water were directly determined. For the gold 10 grms. were digested with nitro-hydrochloric acid; the liquid was diluted somewhat, allowed to settle, and filtered. The filtrate and further washings, which were not quite clear, were collected in a dish and evaporated twice to dryness with addition of HCl. The residue, still containing finely suspended siliceous matter, was next taken up with HCl, the whole transferred to a platinum dish, and treated with solution of HF to remove all SiO_2. When the SiF_4 had gone off, it only then remained to bring the residue again into solution, to filter, and to precipitate the gold by an acid solution of ferrous sulphate. At the end of forty-eight hours the supernatant fluid from this operation was passed through a small filter, and the latter—after washing with warm dilute HCl—was reserved pending the re-solution and re-precipitation of the gold which was finally collected upon it. The weight of gold so obtained was 2·9 m.grms from 10 grms. of material, equal to 9 ozs. 9 dwts. 11½ grs. per ton.

I am unable to speak with confidence as to the presence of silver in my specimen of quartz.

The following are the numbers for the full analysis:—

SiO_2	92·860
Al_2O_3	2·860
Fe_2O_3	1·220
FeS_2	0·266
Au	0·029
MnO	—
CaO	—
MgO	0·180
K_2O	1·398
Na_2O	0·411
Combined water	0·580
	99·804

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING NOVEMBER 30TH, 1887.

By WILLIAM CROOKES, F.R.S.;

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To GENERAL A. DE COURCY SCOTT, R.A., *Water Examiner, Metropolis Water Act*, 1871.

London, December 7th, 1887.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from November 1st to November 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The whole of the 182 samples examined were clear, bright, and well filtered.

Save on the occurrence of exceptional floods, the variations in the character of the river-water supplied to London are, for the most part, very limited in range. Within the range, however, some variation usually makes itself manifest with the coming on of the month of November, and accordingly a slight variation in the composition and character of the water, as prevailing with great uniformity during the previous four months, was recognisable in last month's supply. Thus the mean proportion of organic carbon in the Thames-derived supply was found to be 0·145 part, with a maximum in any one sample examined of 0·166 part in 100,000 parts of the water, as against a mean of 0·137 part, and a maximum of 0·169 part in the preceding four months' supply, the variation, it is observable, being very insignificant.

Similarly as regards the colour-tint of the water—almost always too small to be appreciable by ordinary observation, but capable of being measured by suitable instruments—it is noticeable that while the mean ratio of brown to blue tint in the Thames-derived supply during the preceding four months was found to be as 4·6 to 20, the ratio during the month of November was found to be as 6·5 to 20.

We are, Sir,

Your obedient Servants,

WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

* I have not as yet found carbon in granite, which is perhaps surprising, since this formation is largely made up of quartz.

REPORT OF THE COMMITTEE ON INDEXING CHEMICAL LITERATURE.*

(Concluded from p. 267).

APPENDIX.

[A.] *List of Indexes to Chemical Literature.*

(1) *Uranium*, Index to the Literature of. By H. Carrington Bolton. Annals of the New York Lyceum of Natural History, Vol. IX., February, 1870. 15 pp. 8vo.

(2) *Outlines of a Bibliography of the History of Chemistry*. By H. Carrington Bolton. Annals Lyceum Nat. Hist., Vol. X., pp. 352—361. New York, 1873.

(3) *Manganese*, Index to the Literature of; 1596—1874. By H. Carrington Bolton. Annals of the Lyceum of Natural History, New York, Vol. XI., November, 1875. 44 pp. 8vo.

(4) *Titanium*, Index to the Literature of; 1783—1876. By Edw. J. Hallock. Annals of the N. Y. Academy of Sciences, Vol. I., Nos. 2 and 3, 1877. 22 pp. 8vo.

(5) *Vanadium*, Index to the Literature of. By G. Jewett Rockwell. Annals of the N. Y. Academy of Sciences, Vol. I., No. 5, 1877. 13 pp. 8vo.

(6) *Ozone*, Index to the Literature of; 1875—1879. By Albert R. Leeds. Annals of the N. Y. Academy of Sciences, Vol. I., No. 12, 1880. 32 pp. 8vo.

(7) *Peroxide of Hydrogen*, The Literature of; 1818—1878. By Albert R. Leeds. Annals of the N. Y. Academy of Sciences, Vol. I., No. 13, 1880. 11 pp. 8vo.

(8) *Electrolysis*, Index to the Literature of; 1784—1880. By W. Walter Webb. Annals of N. Y. Academy of Sciences, Vol. II., No. 10, 1882. 40 pp. 8vo.

* *From the Proceedings of the American Association for the Advancement of Science*, Vol. xxxvi.

(9) *Speed of Chemical Reactions*, Literature of. By Robert B. Warder. Proceedings of the Am. Assoc. Adv. Science, Vol. XXXII., 1883. 3 pp. 8vo.

(10) *Starch-sugar*, Bibliography of. By Edw. J. Hallock. Appendix E to report on Glucose prepared by the National Academy of Sciences in response to a request made by the Commissioner of Internal Revenue. U. S. Internal Revenue, Washington, D. C., 1884. 44 pp. 8vo.

(11) *Ozone*, Index to the Literature of, 1879—1883; accompanied by an Historical-Critical Résumé of the Progress of Discovery since 1879. By Albert R. Leeds. Annals N. Y. Academy of Sciences, Vol. III., p. 137, 1884. 16 pp. 8vo.

(12) *Peroxide of Hydrogen*, Index to the Literature of; 1879—1883. By Albert R. Leeds. Annals N. Y. Academy of Sciences, Vol. III., p. 153, 1884. 3 pp. 8vo.

(13) *Dictionary of the Action of Heat upon Certain Metallic Salts*, including an Index to the principal Literature upon the Subject. Compiled and arranged by J. W. Baird, contributed by A. B. Prescott. New York, 1884. 70 pp. 8vo.

(14) *Bibliography of Petroleum*, by Prof. S. F. Peckham. Report on the Production, Technology and Uses of Petroleum and its Products. Report of the tenth census of the United States, Vol. X., 1884, 4to; pp. 281—301. [A comprehensive bibliography of *Bitumen* and its related subjects.]

(15) *A Catalogue of Chemical Periodicals*, by H. Carrington Bolton, Annals N. Y. Academy of Sciences, Vol. III., pp. 159—216. New York, 1885. 8vo. Also Chemical News Print, London, 1886.

(16) *Iridium*, Bibliography of the Metal, by Nelson W. Perry, in Prof. W. L. Dudley's paper on Iridium published in Mineral Resources of the United States, calendar years 1883 and 1884. Washington, 1885. 8vo.

(17) *Uranium*, an Index to the Literature of; 1789-1885. By H. Carrington Bolton. Smithsonian Report for 1885. Washington, 1885. 36 pp. 8vo.

(18) *Explosives*, Index to the Literature of. Part I. By Charles E. Munroe, Baltimore, 1886. 42 pp. 8vo.

(19) *Supplement to a Catalogue of Chemical Periodicals*. By H Carrington Bolton. Annals N. Y. Academy of Sciences, Vol. IV., 1887. 4 pp. 8vo.

(20) *Short Titles of Chemical Periodicals current in* 1887. By H. Carrington Bolton. J. of Analytical Chemistry, Vol. I., Part I., 1887. 4 pp. 8vo.

Note. Copies of 1, 3, 9, 13, 15, 16, 17, 18 and 19 can be obtained by addressing the respective authors. Copies of 2, 4, 5, 6, 7, 8, 11, 12, can be had of Prof. D. S. Martin, New York Academy of Sciences. Copies of 10 can be had of the Commissioner of Internal Revenue. Copies of 14 can be had of the Census Bureau, Washington, D. C.

[B]. *Provisional List of Abbreviations of Titles of Chemical Journals.*

The numbers refer to the Catalogue of Chemical Periodicals by H. Carrington Bolton, New York, 1885, 8vo. Titles 183—196 in the Supplement, New York, 1887 [Nos. 15 and 19 of the preceding list].

1. Afh. Fys. Kemi.
2. Agenda chim.
3. Chem. Ztg.
4. Allg. chem. Bib (Trommsd.)
5. Allg. J. Chem. Scherer
   a N. allg. J. Chem. Gehlen.
   b J. für Chem. Gehlen.
   c J. für Chem. Schweigger.
   d J. prakt. Chem.
6. Alm. di chim. agric.
7. Alm. de chim.
8. Alm. Scheid. Apoth.
   a Taschenb. f. Scheid.
9. Am. Chem. J.
10. Am. Chemist.
11. Am. Lab.
12. Analyst.
13. Ann. Chem. (Liebig).
14. Ann. chim. phys.
15. Ann. di chim. (Brugnatelli).
16. Ann. fis. chim.
17. Ann. Chem. Med.
18. Ann. Chem. Phil.
19. [Refer to 14].
20. Ann. Chym. Pract. Pharm.
21. Ann. Pharm. Bastick.
22. Ann. Phil. (Thomson).
23. Annuaire prod. chim.
24. Annuaire chim.
15. Annuaire sci. chim.
26. Annual Rep. Chem.
27. Anno. alm. pei chim.
28. Anno. chim. ital.
29. Anno. scienze chim. nat.
30. Anno. scienze chim. farm.
31. Anti-Adult. Rev.
32. Arch. der Agr.-Chem.
33. Arch. for Pharm. Trier.
34. Arch. ges. Naturl.
35. Arch. für theor. Chem.
36. Arch. thier. Chem.
37. Arsb. Phys. Chemi.
38. Ausw. Abh. Chem. Crell.
39. Ausw. Ann. Chem. Crell.
40. Beitr. Chem. Wasserberg
41. Beitr. Min. Klaproth.
42. Beitr. Chem. Bucholz.
43. Arch. für physiol. Chem.
44. Ber. d. chem. Ges. (*or* Ber.)
45. Berl. Jahrb. Pharm.
46. Bibl. phys. Lit. (Hermbstädt). Ann. Chem. Lit.
47. Boston J. Chem.
48. J. de pharm.
49. Bull. math. chim. (Férussac).
50. Casopis chem.
51. Centrbl. Agr.-Chem.
52. Chem. Gaz.
    Chem. News.
53. Chem. News Am. Repr.
54. Chem. Record. (Lond.)
55. Chem. Rev. (Lond.)
56. Am. Chem. Rev.
57. Chem. Kal.
57*a*. Techn.-chem. Jahrb.
58. Chem. Ackersmann.
59. Chem. Ann. Crell.
60. Chem. Ind. (Jacobsen).
61. Chem. phys. oefen.
62. Chem. Archiv Crell.
63. Chem. J. Crell.
64. Chem.-pharm. archief.
65. Chem. techn. Mitthl.
66. Chem. techn. Repert.
67. Chemist. Mongredieu.
68. Chemist. Watt.
69. Chem. and Drug.
70. Chem. Advocate.
71. Chem. and Meteor. J. (Amherst).
72. Chem. Desk Comp.
73. Chemists' J.
74. Chimiste, Bruxelles.
75. Chimiste, Paris.
76. Compt. rend. *or* C. R.
77. C. R. chim. Montpellier.
78. Crell's Chem. J. Lond.
79. Deutscher Chem. Kal.
80. Edinb. J. Sci.
81. Fortschr. techn. Chem.
82. Fortschr. theor. Chem.
83. Fortschr. Chem. Köln.
84. Gazz. chim. ital.
85. Gazz. chim. techn. (Sembenini).
86. Gazz. farm. (Sembenini).
87. Gazz. farm. chim. (Venezia).
88. Giorn. fis-chem. ital.
89. Giorn. chim. veterin.
90. Giorn. farm. chim (Gajani).
91. Giorn. di farm. Chiappero.
92. Giorn. di farm. Cattaneo.
    a Bibl. di farm.
    b Ann. di farm. appl. (Polli).
93. Giorn. di fis. Majocchi.
94. Giorn. di fis. Brugnatelli.
95. Obs. sur. phys.
    a J. de phys.
96. Jahrb. Erfind.
97. Jahrb. ökon. Chem.
98. Jsb. Agr.-chem. (Ditmer).
99. Jsb. rein. Chem.
100. Jsb. Agr. Chem.
101. Jsb. chem. Techn. (*or* Wagner's Jsb.)
102. Jsb. phys. Wiss. (*or* Berzelius' Jsb.)
103. Jsb. Chem.
104. Jsb. thier Chem.
105. J. chim. phys. Van Mons.
106. J. chim. med.
107. J. chim. Van Mons.
108. J. der Pharm. Trommsd.
109. J. der Phys. Gren.
    a N. J. der Phys. Gren.
    b Ann. der Phys. Gren.
    c Ann. der Phys. Gilbert.
    d Ann. der Phys. Pogg.
    e Ann. der Phys. Wied.
    f Beibl. Ann. der Phys.
110. J. Phys. Krönig.
111. J. techn. Chem.
112. J. Appl. Chem.
113. Nicholson's J.
114. J. Soc. Chem. Ind.
115. K. phys. chem. Abh.
116. Ztschr. Chem.
117. Laboratorium.
118. Laboratory, Boston.
119 Laboratory, Lond.
120. Listy chem.
121. Mag. f. Apoth. (Elwert.)
    a Report f. Chem. (Elwert).
122. Mag. höhere Naturw.
123. Mech. and Chem.
124. Mél. phys. chim.
125. Mem. prat. chim.
126. Mem. Columb. Chem. Soc.
127. Misc. chim. fis. (Pisa.)
128. Mitthl. Chem. (Kletzinsky).
129. Mitthl. Lab. Chem Brünn.

130. Monatsh. Chem.
131. Monit. prod. chim.
132. Month. Mag. Pharm.
133. Naturh. chem. Notiz.
134. Mag. für Pharm. (Geiger).
135. Orosi.
136. Penny Mech.
137. Pharm. Times.
a Chem. Times.
138. Pharm. Centrbl.
b Chem. Centrbl.
139. Pharmacist.
140. Phil. Mag.
141. Piria.
142. Proc. Am. Chem. Soc.
a J. Am. Chem. Soc.
143. Proc. Chem. Soc.
a Q. J. Chem. Soc.
b J. Chem. Soc.
144. Raccolta fis. chim.
a Ann. fis. Zantedeschi.
145. [Refer to 37.]
146. Recherches phys. - chim.
147. Recueil trav. chim.
148. Rép. chim. Paris.
149. Rép. chim. pure.
Rép. chim. appl.
Bull. Soc. chim. (Paris).
150. Rép. de Pharm. Bruxelles.
151. Rép. de Pharm. Paris.
152. Rep. anal. Chem.
153. Rep. chem. Pharm. St. P.
154. Rep. der Pharm. (Buchner).
155. Rep. org. Chem. (Löwig).
156. Rep. Pharm. Russland.
156*A*. Rev. hebd. chim.
157. Rev. Sc. Quesneville.
a Monit. Sc. Quesneville.
158. Rev. ind. chim.
159. Revista chim.
160. Samml. Abh. Chem. Hochheimer.
161. Scheik. bibl.
162. Scheik. bijdr.
163. Scheik. onderzoek.
164. School Mines Q.
165. Taschenb. Scheik.
166. Techn.-chem. Kal.
167. Techn. - chem. Gewerbebl.
168. Techn.-chem. Jahrb.
169. Tekno-kem. J.
170. Tidssk. anv. Chemi.
171. Tidssk Phys. Chemi.
172. Tijdsch. wet. pharm.
173. Toeg. scheik.
a Maandbl. toeg. scheik.
174. N. Gegenst. Chem. (Richter.)
175. Unters. Liebig's Lab.
176. Vjschr. techn. Chem.
177. Yearbook Pharm.
178. Ztschr. anal. Chem.
179. Ztschr. chem. Grossgew.
180. Ztschr. physiol Chem.
181. Zhurnal. Khim.
182. Zpravy Chem.
183. Bull. assoc. chim. France.
184. Bull. Chem. Soc. Washington.
185. Chemiker. u. Drogist.
186. Chem. - techn. Centrlanz.
187. Deutsche Chem.-Ztg.
188. J. Anal. Chem.
189. Meddel. Carlsberg Lab.
190. N. Y. Analyst.
a Am. Analyst.
191. Skand. Kem. Centrlblad.
192. Suppl. enciclop. chim.
193. Tokyo K. Kaishi.
194. Vjschr. Chem. Nahr.
195. Ztschr. Chem. Ind.
196. Ztschr. phys. Chem.
Am. J. Sci.
Arch. sc. phys.
Jen. Ztschr.
Sitzb. Akad. Berlin.
Sitzb. Akad. Wien.
Phil. Trans. Lond.
Proc. Roy. Soc.
Proc. Am. Acad.
Ann. N. Y. Acad. Sci.
Proc. Acad. Nat. Sci. Phil.

The number of Society Transactions publishing chemical papers is very great, and the list (added at the suggestion of some members of the committee) could be greatly extended.

ANALYSIS OF MICA FROM LEON CO., TEXAS.*

By GEORGE W. LEIGHTON.

This mica, submitted to our examination by Professor Cooke, was received by him from Dr. A. E. Foote, of Philadelphia, who identifies it as the Joakumite of the Texas Academy of Sciences. The mineral attracted notice, as it presented characteristics intermediate between those of the vermiculites and the muscovites, and it was hoped that an analysis might add to our knowledge of the relations between these species.

Description.—The mica is opaque except in thin laminæ, and has obviously undergone alteration. Cleavage basal eminent, laminæ flexible, but brittle and non-elastic Lustre pearly. Colour brownish to yellowish green. Double refraction negative. Biaxial; with bisectrix nearly if not absolutely normal to the cleavage, the optical angle in air measuring about 37½°, but could not be measured accurately on account of opacity. In blowpipe flame the laminæ separate, swelling to more than double the original thickness, and melting on the edges, showing fusibility 5—6. Blowpipe flame strongly coloured with potash, barely tinged with soda, and with traces of lithia. No fluorine could be detected by the usual tests.

The Analysis was made in the usual way, fusing with Na_2CO_3 for the silica, decomposing with HF for the alumina, iron, and magnesia, and by Lawrence Smith's method for the alkalies. The iron was all in the ferric condition, and was determined volumetrically after weighing Al_2O_3 and Fe_2O_3 together. The potash was weighed as chloroplatinate, and the water was determined by ignition. In the following table the results of our analysis are given in Column I. In Column II. are the corresponding per cents of oxygen, and in Column III. are given, for comparison, the results of an analysis of a mica from Hirschburg, taken from Dana's "System of Mineralogy," last edition, and classed by him among the muscovites.

	I.	II.	III.
SiO_2	48·95	26·11	49·04
Al_2O_3	25·17	11·73	29·01
Fe_2O_3	9·40	2·82	5·56
MgO	1·69	0·67	0·75
CaO	trace	—	0·17
Na_2O	trace	—	0·50
K_2O	11·08	1·88	11·19
H_2O	4·31	3·83	4·65
	100·60		100·87

Oxygen Ratios.—Bases with water to silica are as 4 : 5 nearly. Bases without water to silica are as 2 : 3 approximately.

$$RO + H_2O : R_2O_3 : SiO_2 = 5 : 11 : 20.$$
$$RO : R_2O_3 : SiO_2 = 2 : 11 : 20.$$

Conclusions.—Here, then, we have an evident product of alteration, with some of the characters of a vermiculite, which differs in composition from ordinary muscovite mica only in the absence of fluorine, and the presence of a somewhat larger amount of magnesia. Possibly muscovite may pass into vermiculite, and this mica from Texas may represent the first step in the alteration; but if so, intermediate stages must be found, and then this work may help to answer the question. As will be seen, the composition of the Texas mica agrees closely with that of the mica from Hirschburg, the difference in the relative amounts of Al_2O_3 and Fe_2O_3 being unessential.

* *Proceedings of the American Academy of Arts and Sciences.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, December 15th, 1887.

Mr. William Crookes, F.R.S., President, in the Chair

Messrs. Herbert E. Kirby, John Norman Collie, and Sydney Martineau were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Samuel Banner, Sherwood, Sefton Park, Liverpool; Arthur G. Bloxam, Royal Agricultural College, Cirencester; Lewis Walter Hawkins, 18, Burr Street, London, E.; Stevenson J. C. G. Macadam, Brighton House, Portobello, Edinburgh; Sidney Skinner, B.A.

Christ's College, Cambridge; Charles Francis Townsend, Ashley Road, Epsom; Alfred Edwin Tutton, 12, South Parade, Brompton, S.W.

The following papers were read:—

92. "*An Apparatus for Comparison of Colour-Tints.*" By Alfred W. Stokes.

In operations such as Nesslerising in water analysis, when it is necessary to compare a number of depths of tint with one another, it is very inconvenient to have to make up a large series of standard tints. The author has devised an apparatus which obviates this necessity. It consists of a base-board on which lies a sheet of white opal glass. Placed obliquely a little way above this is a sheet of glass on which rest the Nessler-tubes containing the solutions whose tints are to be compared. The mouth-ends of these tubes recline in grooves hollowed in a horizontal bar. This bar is supported by two pillars, on one of which slides a ring clasping a calibrated glass tube: this tube has a side tubulure at the base, and is thus and by means of a short india-rubber tube connected with a similar but uncalibrated tube resting on the glass plate. A known quantity of the standard colour being placed in the tube carried by the ring and diluted with water up to the top mark, if the movable tube be raised this standard solution will flow into the tube resting on the glass plate. The movable tube is calibrated to show how much is present in the other tube. Hence, if a Nessler-tube containing liquid of unknown depth of tint be placed beside the tube on the glass plate, and the tube in the sliding ring be raised or lowered till the tints agree in the two tubes resting on the glass plate, a simple inspection of the level of the liquid in the calibrated tube will give the quantity of standard colour the unknown solution is equal to.

The apparatus is especially useful in Nesslerising; also in determinations of the quantity of lead present in waters, and in other cases where comparison of tint depths is necessary.

93. "*The Alloys of Copper and Antimony and of Copper and Tin.*" By E. J. Ball, Ph.D.

The author gives the results of experiments instituted with the view of obtaining further evidence as to whether the alloys Cu_2Sb and Cu_4Sb, which are indicated by changes in the direction of the curve by which the electrical conductivity of the copper-antimony alloys is expressed, are or are not compounds. Copper, antimony, and lead were melted together in varying proportions, lead being a metal which alloys only to a very slight extent with copper. Mixtures of Cu_2Sb and lead were first made, the first alloy containing 95 per cent of lead, the second 90 per cent of lead, and so on for the remainder of the series. No alloys could be formed between the one with 20 per cent and that with 65 per cent of Cu_2Sb. The intermediate mixtures that had separated on solidification were all melted up together and allowed to cool slowly, with the result that owing to the partial oxidation and consequent loss of antimony in the successive fusions and castings, the metal was found to have separated on solidification into three alloys of different densities. The upper of these had the composition Cu_4Sb, the alloy which occupies the lowest position on the conductivity curve. The mixture of 75 lead and 25 Cu_2Sb, the first that separated after fusion, when cast in a cylindrical mould, separated on cooling into two concentric cylinders, the inner of which had the same composition as that of the last alloy that formed before the separation of the fused mixture into two alloys, *i.e.*, 80 lead and 20 Cu_2Sb. The author is of opinion that this represents the saturated solution of Cu_2Sb in lead. The alloys were then cast into discs, which were ground to the same size and examined by the aid of the Hughes induction balance. The curve of relative conductivity so obtained was practically a straight line between the terminal points. In view of this fact, and since in their general appearance the alloys resemble both in colour and structure mixtures of Cu_2Sb and lead, it would appear that Cu_2Sb exists in these alloys as such.

In the second series of alloys the first mixture consisted of 95 antimony, 2·5 lead, and 2·5 copper; the second of 90 antimony, 5 lead, and 5 copper. These alloys were all more or less grey in colour, and their fracture became conchoidal as the alloy approached in composition Cu_4Sb. The induction balance curve rose gradually, till the copper and antimony were almost in the proportions necessary to form Cu_2Sb, and then fell again as this point was passed.

In the third series the first alloy formed contained 95 copper, 2·5 lead, and 2·5 antimony; the second contained 90 copper, 5 lead, and 5 of antimony. All the alloys of this series formed, except the one with 50 copper, 25 lead, and 25 antimony: this separated on cooling into an alloy which was again found to have the composition Cu_4Sb and lead containing antimony and copper. The induction balance curve of this series, allowing for the dilution of the copper-antimony alloys by lead, is identical with that of the copper-antimony alloys free from lead. Throughout these three series of alloys the lead appears to be wholly without influence on the physical properties except that which it exercises as a diluent, the influence of the alloys forming the turning-points of the conductivity curve, Cu_2Sb and Cu_4Sb, being as marked in the presence of lead as when that metal is absent. Hence the author believes that these two alloys are true compounds. When they are fused with silver sulphide, the copper in both Cu_2Sb and Cu_4Sb is to a great extent displaced by silver, without greatly altering the character of the alloy.

Copper-tin alloys were treated with lead in a similar manner, and in this case also the lead appeared to be without effect on the general character of the alloys, the influence of the alloys, which are indicated by the turning-points of the conductivity curve, viz., Cu_3Sn and Cu_4Sn, being as marked as in the case of the turning-points of the copper-antimony alloys Cu_2Sb and Cu_4Sb.

Discussion.

Prof. Roberts-Austen said that the alloy of copper and antimony known as the "Regulus of Venus" is the only alloy having an intense violet colour, which made it an object of great interest to the alchemists, but it had been strangely neglected by their successors in modern times. Lead unites readily with antimony, and it therefore appeared not improbable that lead would induce a certain amount of antimony to leave the copper and form triple alloys; but Dr. Ball had shown that the antimony and copper alloys remained intact, and that lead merely diluted them. This was specially interesting because—to turn to other metals—it is well known that zinc and lead, if melted and mixed in the fused state, separate from each other almost entirely on cooling. Notwithstanding this fact, A. and L. Svanberg had shown that in the presence of a third metal—viz., tin—lead and zinc will unite to form a triple alloy, $ZnSn_3+2PbSn_3$, which solidifies at 168° C. It was generally assumed that rapid cooling prevented the "liquation" or separation of the constituents of alloys, but the speaker had shown in the case of the silver-copper alloys that *slow* cooling produced products as uniform in composition as Levol's alloy containing 71·8 per cent of silver, the only alloy of the series which was formerly believed to be uniform in composition.

Prof. Roberts-Austen added that he was glad of the new evidence afforded by the author's observations of the delicacy of the Hughes induction balance, an instrument which he had long since predicted would prove to be of great service in studying the molecular constitution of alloys.

Dr. C. R. Alder Wright said that the determination of the constitution of ternary alloys involved the solution of some very interesting problems, which in certain cases appeared to be of a far more complex order than was generally supposed. A great distinction was to be made between the amount of permanent miscibility possible

with fluid metals whilst kept molten by heat, and the more or less complete segregation taking place during solidification on cooling, especially when slowly effected. In the latter case the separation appeared frequently to be regulated by the formation of alloys of definite constant compositions, atomic or otherwise, which possessed fusing-points higher or lower than those of the rest of the masses; so that one portion solidified first, leaving, so to speak, a more fusible mother-liquor. But it was quite different in the former case: with certain metals in certain proportions the mixture when melted, well stirred together and then left quiescent for some time in a molten condition, separated into two layers, just as a mixture of ether and water, or certain mixtures of ether, alcohol, and water would do if shaken up and then allowed to stand: the relative proportions in which the metals divided themselves were doubtless regulated by some law, because one given mass always divided itself in one way, and another in another, and so on; but this law or guiding principle did not seem to be connected with combination in atomic proportions, nor upon the production of any one particular alloy which formed and separated from the rest of the mass. He was not in a position at present to indicate what really was the guiding principle in such cases, but hoped that some experiments upon which he and Mr. C. Thompson were now engaged would throw light on the question. These experiments were being carried out with various mixtures of lead, zinc, and tin or bismuth: thus, for example, a series of ingots were made by mixing equal weights of lead and zinc in each case with varying amounts of tin, melting together, well stirring and keeping molten for one to two hours, and then cooling without more delay than was absolutely necessary in order to diminish possible sources of error through incipient segregation during solidification taking plare in either the bottom or the top one of the two layers into which the molten mass divided itself during the period of quiescence. The top and bottom portions being analysed and the lead and tin calculated per unit of zinc in the first case, and the zinc and tin per unit of lead in the second, and these pairs of values being plotted off as abscissæ and ordinates respectively, curves were obtainable from comparison of which he hoped to be able to deduce the guiding principle. In each case the amount of zinc taken up by the heavier alloy in which lead predominated, and that of lead in the lighter alloy in which zinc predominated, increased with the amount of tin present, but not always in the same ratio. Moreover, the relative proportions in which the tin divided itself between the bottom and top layers was not constant, but varied with the proportion of tin in the total mass; so that the production of atomic compounds of the metals, even if it occurred at all, was certainly not the sole explanation of the results. The principle of two saturated solutions being formed also appeared to be inapplicable.

In answer to a further question by Dr. BALL, Dr. ALDER WRIGHT said that his experiments were as yet hardly complete enough to enable him to pronounce definitely, but he thought that the formation of an eutectic alloy would not afford an adequate explanation, because, if this were the case, either the top or the bottom layer (presumably the latter, being usually the more fusible) should exhibit constancy of composition which was very far from being the case; the principle of eutexia no doubt largely regulated the solidification of molten masses on cooling; but it did not seem to be so closely connected with the miscibility of molten metals kept fluid throughout. As regards avoiding loss by oxidation during fusion and volatilisation of zinc, he had found that a little cyanide of potassium previously fused in the melting-pot largely if not entirely prevented both sources of alteration, and was preferable for this purpose to borax or metaphosphate of soda, &c., as these substances did not exert any reducing action, but simply cleansed the metal by dissolving any oxide that might be formed.

94. "*The Constitution of the so-called Mixed Azo-Compounds.*" By FRANCIS R. JAPP, F.R.S., and FELIX KLINGEMANN, Ph.D.

The authors find that diazobenzene chloride interacts with ethylic sodiomethacetoacetate to form acetic acid and an ethereal salt, $C_{11}H_{14}N_2O_2$ (m.p. 117°), which by hydrolysis is converted into the acid $C_9H_{10}N_2O_2$ (m.p. 185°). They have also prepared homologues of these compounds, substituting ortho- and para-diazotoluene for diazobenzene, and ethylic ethacetoacetate for methacetoacetate. They at first regarded the acid $C_9H_{10}N_2O_2$ as benzene-azo-propionic acid, $C_6H_5{\cdot}N_2{\cdot}CH(CH_3){\cdot}COOH$ (see *Ber.*, xx., 2942). It yields on reduction a hydrazo-acid, $C_9H_{10}N_2O_2$ (m.p. 170°), which proved to be the α-phenylhydrazidopropionic acid of Fischer and Jourdan, obtained by reduction of phenylhydrazinepyruvic acid. On comparing the supposed benzene-azo-propionic acid with phenylhydrazinepyruvic acid, it was found that the two compounds were identical, the melting-point (169°) given by Fischer and Jourdan being much too low. It therefore appeared probable that the acid was a hydrazide: this view is supported by the following proof that "benzene-azo acetone," hitherto formulated—

$$CH_3{\cdot}CO{\cdot}CH_2{\cdot}N_2{\cdot}C_6H_6,$$

is in reality a hydrazide of the formula—

$$CH_3{\cdot}CO{\cdot}CH : N{\cdot}NHC_6H_5,$$

derivable from pyruvic aldehyde.

By acting on "benzene-azo-acetone" with sodium ethoxide and ethylic chloracetate, an ethereal salt was obtained which on hydrolysis yielded an acid of the formula $C_{11}H_{12}N_2O_3$ (m.p. 161° to 162°). By reduction this acid gave anilido-acetic acid, but no aniline, thus proving that it has the formula—

$$CH_3{\cdot}CO\,CH : N{\cdot}N(C_6H_5)CH_2{\cdot}COOH.$$

If "benzene-azo-acetone" had the formula hitherto ascribed to it, the introduction of $CH_2{\cdot}COOH$ into the methylene-group would have occurred and the resulting compound would have yielded aniline on reduction.

The above view is confirmed by the fact that the phenylhydrazide of "benzene-azo-acetone" proves to be identical with the dihydrazide—

$$C_6H_5NH{\cdot}N : CH{\cdot}C(CH_3) : N{\cdot}NHC_6H_5,$$

recently obtained by Von Pechmann from methylglyoxal (pyruvic aldehyde) and phenylhydrazine.

The authors therefore regard the various so-called mixed azo-compounds obtained by the action of diazo-salts upon compounds of the ethylic acetoacetate type, as hydrazides. They point to the parallel case of the formation of isonitroso-compounds (hydroximes) by the action of nitrous acid, and suggest that this analogy would be more perfect if *free* diazobenzene were regarded as the anilide of nitrous acid thus: $ON{\cdot}NHC_6H_5$. Experiments are being undertaken in support of this view. They had intended to study the action of reducing agents on the alkyl-derivatives of the benzene-azo naphthols in order to settle the question, already mooted by Zincke, as to whether the latter are azo-compounds or hydrazides; but have renounced this intention on learning that Prof. Meldola is engaged in investigating this subject.

95. "*The Interpretation of Absorption Spectra.*" By G. H. BAILEY.

96. "*The Reduction of Potassium Bichromate by Oxalic Acid.*" By C. H. BOTHAMLEY, Assistant Lecturer on Chemistry, Yorkshire College.

Potassium bichromate and hydrated oxalic acid, finely powdered and intimately mixed, interact spontaneously after two or three hours, or instantly if heated to 30° to 35°; after heating at 110° to 120° until the weight is constant, a dark friable residue is obtained which is completely soluble in water. If the mixture which has been heated at 110° to 120° is heated over a low flame, care being taken to avoid fusion, further decomposition ensues, and on treatment with water chromic oxide remains un-

dissolved and a solution of potassium chromate free from oxalic acid and chromic salts is left.

If dehydrated oxalic acid be taken the interaction does not take place spontaneously, but occurs instantly at 30° to 35°, the product being a very bulky porous and friable grey solid; the nature and limit of the interaction is, however, the same as with the hydrated acid.

With an excess of oxalic acid reduction is complete, but with excess of bichromate the interaction is different. The first stage of the interaction, which takes place at a temperature not exceeding 120°, is represented by the equation—

$$2K_2Cr_2O_7+6H_2C_2O_4=Cr_2(C_2O_4)_3+6H_2O+6CO_2+2K_2CrO_4.$$

The decomposition is limited, even in presence of excess of bichromate, by the formation of chromic oxalate, which is not further oxidised at 120°. At a higher temperature in presence of only a slight excess of bichromate the chromic oxalate decomposes in accordance with the equation $Cr_2(C_2O_4)_3=Cr_2O_3+3CO+3CO_2$. If, however, a considerable excess of bichromate is present further oxidation takes place thus :—

$$2K_2Cr_2O_7+Cr_2(C_2O_4)_3=2Cr_2O_3+6CO_2+2K_2CrO_4.$$

The complete oxidation of oxalic acid in presence of a large excess of potassium bichromate is represented by the equation—

$$4K_2Cr_2O_7+6H_2C_2O_4=2Cr_2O_3+4K_2CrO_4+6H_2O+12CO_2.$$

97. "*The Reduction of Chlorates by the Zinc-Copper Couple.*" By C. H. BOTHAMLEY and G. R. THOMPSON.

When a solution of potassium chlorate is reduced by means of the zinc-copper couple (Thorpe, *Trans.*, 1873, 541) a portion of the reduced chloride is converted into zinc oxychloride, which is insoluble in water but readily soluble in dilute sulphuric acid. The quantity of oxychloride formed is greater the more concentrated the solution. In order to avoid the error due to this cause the chlorate solution is heated with the couple for about one hour, and pure dilute sulphuric acid is then added until the zinc hydroxide and oxychloride just dissolve. The liquid is filtered, neutralised with calcium carbonate, and titrated with silver nitrate. Thus modified, the method gives very accurate results; the solution should not contain more than 1·5 grms. of potassium chlorate in 25 c.c., and should just cover the couple.

98. "*Preliminary Notice on the Oxidation of Oxalic Acid by Potassium Dichromate.*" By EMIL A. WERNER, Assistant in the Chemical Laboratory, University of Dublin.

In the course of an investigation of chromoxalates and analogous chromium compounds with other organic acids, ths results of which have already been partly published (*Trans.*, 1887, 383), I was led to study the action of oxalic acid on potassium dichromate solutions i n presence of sulphuric acid. The results already obtained seem noteworthy, and in view of the fact that a paper on the same or a similar subject is announced, I send the following short note :—

In the preparation of the blue chromoxalates already described, 9 mols. of oxalic acid are required for the complete reduction of each molecule of potassium dichromate; in this interaction the oxalic acid is divisible into two distinct portions, viz., 3 mols. which are used ap in the reduction of the dichromate, and 6 mols. which combine with the reduced chromium to produce the chromoxalate : *e. g.*,—

$$2KCr_2O_7+6H_2C_2O_4+3H_2C_2O_4=K_2H_4Cr_2(C_2O_4)_6+7H_2O+6CO_2.$$

I have endeavoured to use instead of the persistent 6 mols. oxalic acid their equivalent of succinic acid, but I find that the interaction proceeded in an entirely different manner; only a *partial reduction* of the dichromate is effected by the 3 *mols.* of oxalic acid, and no compound whatever of chromium and succinic acid is produced, the final products of the reaction being—(1), the red chromoxalate of Crofts, $K_2Cr_2(C_2O_4)_4$; and (2), free $K_2Cr_2O_7$ (about two-fifths of the original amount), the succinic acid remaining unaltered.

If oxalic acid be added until the dichromate is all reduced, 9 *mols. are required*, and the interaction proceeds exactly as in the absence of the succinic acid. An attempt to effect a partial replacement of the oxalic by succinic acid was attended with the same result.

From these results I was led to investigate more closely the oxidation of potassium dichromate by oxalic acid in presence of sulphuric acid, and while looking over the literature of the subject I was struck by the following account of the method of preparing chrome-alum in "Watts's Dictionary" (3rd Supplement). In the preparation of chrome-alum by the action of sulphuric acid on potassium dichromate, the reduction of the latter may be conveniently effected by oxalic acid, when it is not necessary to add an excess of the reagent, as the reaction is complete when CO_2 ceases to be evolved, &c. The equation representing the change is as follows :—

$$K_2Cr_2O_7+4H_2SO_4+3H_2C_2O_4=K_2Cr_2(SO_4)_4+6CO_2+7H_2O.$$

29·5 parts of dichromate are dissolved in 39 parts of sulphuric acid and the necessary amount of water, and 38 parts of oxalic acid added gradually in small portions (Lielegg, *Dingl. Polyt. J.*, ccvii., 321). The production of chrome-alum by this method is entirely dependent on the "necessary amount of water," the above equation being only true when little or no water is present, dilution of the mixture causing only partial reduction of the dichromate, with production of varying amounts of red chromoxalate and chromium sulphate, the former increasing and the latter diminishing with the degree of dilution, and *vice versâ*. I am at present engaged in investigating this reaction in all its details, with special reference to the influence of mass and temperature.

The remarkable affinity existing between chromium and oxalic acid as shown in these reactions, becomes all the more interesting when compared with the not less remarkable inert behaviour of chromium towards succinic acid. All attempts hitherto to obtain compounds corresponding to the chromoxalate containing succinic acid have been unsuccessful; in fact *freshly* precipitated chromic hydroxide is perfectly insoluble in excess of succinic acid solution at the boiling temperature, and when heated in sealed tubes at 120° to 130° C. only a mere trace of the chromium enters into solution.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, October 18th, 1887.

Professor BALFOUR STEWART, LL.D., F.R.S., President, in the Chair.

"*On the Possible Equations expressing the Decomposition of Potassic Chlorate by Heat.*" By JAMES BOTTOMLEY, D.Sc., B.A., F.C.S.

It has long been known that potassic chlorate, when heated, is resolved into oxygen, potassium chloride, and a more highly oxygenated product, potassium perchlorate, the equation expressing the change being usually written—

$$2KClO_3 = KClO_4 + 2KCl + O_2.$$

Lately the decomposition of the salt has been investigated by Teed, and also by P. Frankland and Dingwall, their results being communicated to the Chemical Society. Teed, from his results, derives the equation—

$$10KClO_3 = 6KClO_4 + 4KCl + 3O_2,$$

and in a second communication giving the results of experiments wherein the salt was more gently heated, he gives as a more approximate equation—

$$22KClO_3 = 14KClO_4 + 8KCl + 5O_2.$$

P. Frankland and Dingwall derive from their results the equation—

$$8KClO_3 = 2O_2 + 5KClO_4 + 3KCl.$$

The matter has also been discussed by Mills in the April number of the *Philosophical Magazine*. He there gives the following equation as expressing all known relations among those products:—

$$(1)\ 2nKClO_3 - (n-2)O_2 = (n+1)KClO_4 + (n-1)KCl.$$

Some years since I gave a general method for determining the coefficients in chemical equations (*Proc. Lit. and Phil. Soc.*, vol. xvii.). Suppose P molecules of $KClO_3$ to interact and give rise to Q_1 molecules of $KClO_4$, Q_2 molecules of KCl, and Q_3 molecules of O, then we shall have the equation—

$$(2)\ PKClO_3 + Q_1KClO_4 + Q_2KCl + Q_3O_2$$

equating the coefficients of K on each side—

$$P = Q_1 + Q_2,$$

the coefficients of Cl, when equated, give a similar equation. From the coefficients of O we derive the equation—

$$3P = 4Q_1 + 2O_2.$$

Hence we have four unknown quantities and only two equations Substituting in (2) we get—

$$(3)\ 2PKClO_3 = 2Q_1KClO_4 + 2(P - Q_1)KCl + (3P - 4Q)O_2$$

an equation containing two variables with the condition that P and Q are integers and 3P not less than 4Q. From the equation it is manifest that from the interaction of a given number of molecules of $KClO_3$ we may have several solutions of the equation: the number of solutions may be found by finding the largest integer in $\frac{3P}{4}$; an additional solution may be found if we admit *o* as a possible value of Q_1.

P=11, the following equations are possible—

$$\begin{aligned}22KClO_3 &= 2KClO_4 + 20KCl + 29O_2\\ &= 4KClO_4 + 18KCl + 25O_2\\ &= 6KClO_4 + 16KCl + 21O_2\\ &= 8KClO_4 + 14KCl + 17O_2\\ &= 10KClO_4 + 12KCl + 13O_2\\ &= 12KClO_4 + 10KCl + 9O_2\\ &= 14KClO_4 + 8KCl + 5O_2\ (7)\\ &= 16KClO_4 + 6KCl + 1O_2\end{aligned}$$

Of these (7) is the equator given by Teed.

If in (1) we make $n=2$, the equation becomes—

$$4KClO_3 = 3KClO_4 + KCl;$$

if P=2 in equation (3) we have—

$$4KClO_3 = 4KCl + 6O_2,$$

and—

$$4KClO_3 = 2KClO_4 + 2KCl + 2O_2$$

Equation (3) may be converted into equation (1) by writing $\frac{P(n+1)}{2n}$ for Q, *n* being a new variable, and then multiplying both sides of the equation by $\frac{n}{P}$. If in (3) we P=1, we cannot derive the equation usually given without employing a fractional value ($\frac{1}{2}$) for Q. Can this imply that the equation is impossible, for can we have a fraction of a molecule? The arbitrary connections of P and Q may be shown as follows:—Collecting the terms involving P on one side and those involving Q on the other, we have—

$$P \times (2KClO_3 - 2KCl - 3O_2) = Q \times (2KClO_4 - 2KCl - 4O_2),$$

or—

$$P \times o = Y \times o.$$

Ordinary Meeting, November 1st, 1887.

Mr. John Angell, F.I.C., F.C.S., in the Chair.

Professor Schuster mentioned some experiments made by Prof. Hertz, of Carlsruhe, pointing to a curious effect of light in the electric discharge. It seems, according to these experiments, that when ultra-violet light is allowed to fall on spheres of metal between which electric sparks are produced, the sparks pass more easily, and can be obtained of greater length.

Dr. Hodgkinson mentioned an electrical property of quartz which he had observed, and which, if established, prove the unsuitability of this substance as a covering medium for compasses, watches, and other magnetisable instruments.

Ordinary Meeting, November 16th, 1887.

Professor Balfour Stewart, LL.D., F.R.S., President, in the Chair.

"*On the Electrical Attraction of Quartz, and the Unsuitability of this Substance as a Protecting Medium for Compasses, Watches, &c.* By Alex. Hodgkinson, M.B., B.Sc.

Quartz, like most other substances, becomes electrified by friction, and also possesses the property of remaining in an electrified condition for a period varying from ten minutes to half an hour after the friction has ceased. When this medium is used as a cover for compasses, this electrical property may manifest itself in such a marked manner as to render the readings of the instrument utterly unreliable, and more especially is this the case where the instrument is provided with a quartz cover back and front. In the compass exhibited the back and front of the instrument consist of two plano-convex lenses of quartz with their plane surfaces towards each other, the needle rotating between these covers on an axis, the extremities of which fit into two conical holes in the centre of the quartz covers. In the case of this instrument the mere act of removing it from the warm pocket is usually sufficient to cause the needle to assume a fixed position in relation to the compass itself, and quite unaffected by the magnetic attraction of the earth. If, whilst in this condition, the instrument is rotated, the needle also rotates as if a fixture. If the surface of the quartz be rubbed with the dry finger in a radial direction the needle at once takes up a position in the same direction, and if compelled by shaking to change its position it resumes it when allowed to remain at rest. When the compass is so turned that the axis of the needle is in the direction of the magnetic force of the earth, and the needle therefore in equilibrium, the effects of radial friction become still more marked. As might be expected, the property is not confined to quartz. A compass covered with glass exhibited the same phenomena, with the important difference that in this case the attractive influence ceased with cessation of the friction. That the attractive influence is quite independent of the magnetic force of the needle is proved by the fact that an instrument similar in every respect to the first-mentioned instrument, excepting that the needle was left unmagnetised, exhibited the same phenomena. The action is therefore one of simple electrical attraction.

CORRESPONDENCE.

ANALYSES OF MIXED PAINTS.

To the Editor of the Chemical News.

Sir,—In answer to your correspondent, R. S., the analysis of mixed paints will depend on whether he is dealing with "pigments ground in oil" or paints mixed "ready for use."

A weighed quantity of the pigment ground in oil is placed in a plugged filter tube, and is carefully washed with carbon disulphide until all traces of oil are removed.

The disulphide is evaporated when the weight of oil is obtained.

Mixed paints may be treated in the same way, using petroleum spirit instead of carbon disulphide, The oils, &c., thus extracted will consist of linseed oil, boiled oil, perhaps resinous matter, &c., turpentine, shale spirit, or petroleum: these two latter are largely used to replace turpentine.

To separate and estimate the oils, chloride of sulphur is added, when the oils will be precipitated, and the weight of turpentine, &c., may be obtained by difference. Resin, if present, may be extracted by alcohol from the matter removed by carbon disulphide; alcoholic solution of soda in some cases is necessary for this purpose.

The pigments are thus obtained in a dry state, free from oil, and may be examined in the usual way.

It is a common practice to burn off the oils, &c., but this is a mistake, as we ought to know something of the "body" giving material, as well as of the *et ceteras* used in rendering the paint "fit for use."—I am, &c.,

THOMAS T. P. BRUCE WARREN.

Tamworth Villa, Earlham Grove,
Forest Gate, E.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cv., No. 22, November 28, 1887.

Action of Vanadic Acid upon Potassium Fluoride. — A. Ditte.— Vanadic acid, melted with potassium fluoride, forms compounds more or less rich in fluorine. The same compounds are produced in the presence or in the absence of air, though in the former case a certain quantity of potassium vanadate is also formed.

Ammoniacal Zinc Cyanides.—Raoul Varet.—Unlike the zinc chloride, bromide, and iodide, zinc cyanide yields, with ammonia, only two compounds according as water is present or absent.

Application of a Process of Senarmont's to the Production of Celestine and Anglesite in the Moist Way.—L. Bourgeois.—The process adopted was heating respectively strontium sulphate and lead sulphate in hydrochloric acid under pressure.

An Alkaloid extracted from the Fruit of Solanum grandiflora.—Sen. Domingos Freire.— The alkaloid in question—to which the author gives the name grandiflorine—is, like the fruit from which it is extracted, a powerful poison. The base gives the general reactions common to vegetable bases, but it has not yet been obtained in quantity sufficient for quantitative analysis.

Meteorites in Spectral Analysis. — M. Stanislas Meunier.—The author thinks that there is room to protest, in the name of Natural History properly so-called against the assimilation established in the recent memoir of Mr. Norman Lockyer, between meteorites and molecules which are amorphous, or at least whose physical and chemical properties may be considered independent of their structure. It must be remembered that meteorites are aggregations of different minerals, often very complicated, whose existence supposes the successive play of determina le actions. The meteorite of Pallas cannot have resulted from reactions in the way of fusion, and its nature supposes naturally the anterior existence of an extensive and bulky total, of which it formed a part. It comprises, with a very regular structure, minerals so unequally fusible that the application of heat must disorganise it, as it would destroy an animal or vegetable structure.

Revue Universelle des Mines et de la Metallurgie. Vol. xxi., No. 3, May and June, 1887.

Modification of the Bichromate Volumetric Process for the Determination of Iron in Ores.—H. Bya.—In most cases iron exists in ores in the ferric state. For applying the bichromate method it must be previously reduced to the ferrous state. Hitherto this has been exclusively effected by the nascent hydrogen evolved by the action of zinc upon the acid added to the solution of the ore. But if we take as reducing agent stannous chloride the action is, practically speaking, instantaneous. To eliminate from the solution the stannous chloride which is there present in slight excess, we add an excess of mercuric chloride; a portion of this is reduced, forming mercurous chloride, which is precipitated, whilst the stannous chloride is transformed into stannic chloride. The ferrous solution may then be directly titrated with potassium dichromate.

Iodide of Starch.—After working upon cholic acid and more particularly upon an iodised compound of this acid, which behaves in a manner analogous to the iodide of starch, F. Mylius re-investigated the latter compound, arriving at the very unexpected conclusion that pure iodine does not colour starch blue; to obtain this colouration the presence of hydriodic acid or of a soluble iodide is necessary. The blue products known as iodide of starch should be compounds of 4 mols. iodide of starch with 1 mol. of hydriodic acid or of a soluble iodide.

Determination of Potassium Permanganate and of Manganese Dioxide with Hydrogen Peroxide.—H. Bya.—Dr. Lunge has formerly shown that permanganate, like chloride of lime and potassium ferricyanide, may be determined by treatment with oxygenated water in excess, measuring the volume of oxygen evolved in the nitrometer. In this case the available oxygen of the permanganate will be exactly equal to half the oxygen set at liberty. The analysis of peroxide of manganese can be effected in a similar manner. The sample of manganese in fine powder is first shaken up in the exterior portion of the analysis bottle with dilute sulphuric acid to eliminate any carbonic anhydride present. An excess of hydrogen peroxide is then poured into the small interior tube, the bottle is connected to the nitrometer, the substances are mixed by inclining the apparatus, and shaken until the decomposition is complete. Weldon mud may also be determined in the same manner.

Archives Neerlandaises des Sciences Exactes et Naturelles. Vol. xxii., Part 1, 1887.

The Non-Chlorophyllic Colours of Leaves and their Signification for the Decomposition of Carbonic Acid under the Influence of Light.—Th. W. Engelmann.—The author discusses the question in what degree the different groups of rays of the spectrum participate in the decomposition of carbonic acid in the assimilating organs of plants. He takes up the indirect method, examining what groups may be wanting without a cessation of assimilation. A mixed light complementary of the special colour of the assimilant chromophyll is the most efficacious in decomposing carbonic acid. Hence, where the incident light is deprived of red rays, red forms prevail in the struggle for existence.

On Some Derivatives of Inosite and its Chemical Function.—M. Maquenne.—The derivatives here studied are the hexacetic and hexa-benzoic inosite, hexa-nitro-inosite, and tetra-benzoyl-tetra-oxyquinone. Inosite is an hexatomic alcohol, comparable in all points with mannite, save in the facility with which it passes into the benzinic series by the loss of hydrogen or hydroxyl. It must not be regarded as an aromatic body, but as a mannite with a closed hexagonal chain.—*Bull. de la Soc. Chim. de Paris.*

MISCELLANEOUS.

City and Guilds of London Institute.—A Course of ten Lectures on the Chemistry of Oils and Fats will be delivered at the Central Institution, by Dr. A. K. Miller, Demonstrator and Assistant in the Chemical Research Laboratory, on Mondays at 4 p.m., during the Spring term, commencing on January 23rd, 1888. SYLLABUS: *Oils of Mineral Origin.*—Petroleum: occurrence, production, and treatment; purification, properties and uses of the various products, their composition, chemical and physical properties, and their examination for commercial purposes. Theories relating to the origin of petroleum. Shale oil. Paraffin. Manufacture of oil-gas. *Oils, Fats, &c., of Vegetable and Animal Origin.*—Volatile oils, including turpentine. Fixed oils and fats: occurrence, extraction, and estimation. Physical properties. Constitution, decomposition, and chemical reactions. The different series of so-called fatty acids. Soaps. Glycerine. The chemical examination of oils, fats, and waxes; their classification, and the discussion of the properties, uses, tests, &c., of the chief members of each class.

At the Finsbury Technical College a Course of about six Lectures on Photographic Chemistry will be delivered by Prof. R. Meldola, F.R.S., F.I.C., F.C.S., commencing on Wednesday, January 18th, and being continued on successive Wednesdays. The Lectures will commence at 7.30 p.m. The object of this course is to develop the scientific principles upon which modern photography is based, so as to enable professional and amateur photographers to keep abreast of recent advancements in the subject. Those who attend the Lectures will have the opportunity, if they desire it, of receiving practical laboratory instruction in the testing and valuation of photographic chemicals. SYLLABUS OF LECTURES.—The action of light upon elements and compounds. Photo-physical and photo-chemical changes. Combinations and decompositions effected by light. The photo-chemical reactions of the salts of iron, mercury, uranium, copper, gold, platinum, the chromates, &c. Specific action of light and of the spectral colours on the salts of silver. Effects of the compounds associated with silver salts. Different molecular states of the silver haloid compounds. Recent researches on the photochlorides.

On Certain Derivatives of Dinaphthyl.—Paul Julius.—The author describes the preparation of the dinaphthols α and β, the sulpho-conjugation of the latter of these compounds, the preparation of dinitro-β-dinaphthol disulphonic acid, and the azo-compounds of α-dinaphthol.—*Mon. Sci*

MEETINGS FOR THE WEEK.

MONDAY, Jan. 2nd.—Medical, 8.30.
TUESDAY, 3rd.—Pathological, 8.30. (Anniversary
—— Royal Institution, 3. "Astronomy: The Great Planets," by Sir Robert Stawell Ball, LL.D. F.R.S.
THURSDAY, 5th.—Royal Institution, 3. "Astronomy: The Comets by Sir Robert Stawell Ball, LL.D., F.R.S.
FRIDAY, 6th.—Geologists' Association, 8.
SATURDAY, 7th.—Royal Institution, 3. "Astronomy: The Stars,' by Sir Robert Stawell Ball, LL.D., F.R.S.

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ST. PAUL'S SCHOOL.—An Examination for filling up about Six Vacancies on the Foundation will be held on the 18th of January next.—For information apply to the Bursar, St. Paul's School, West Kensington.

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